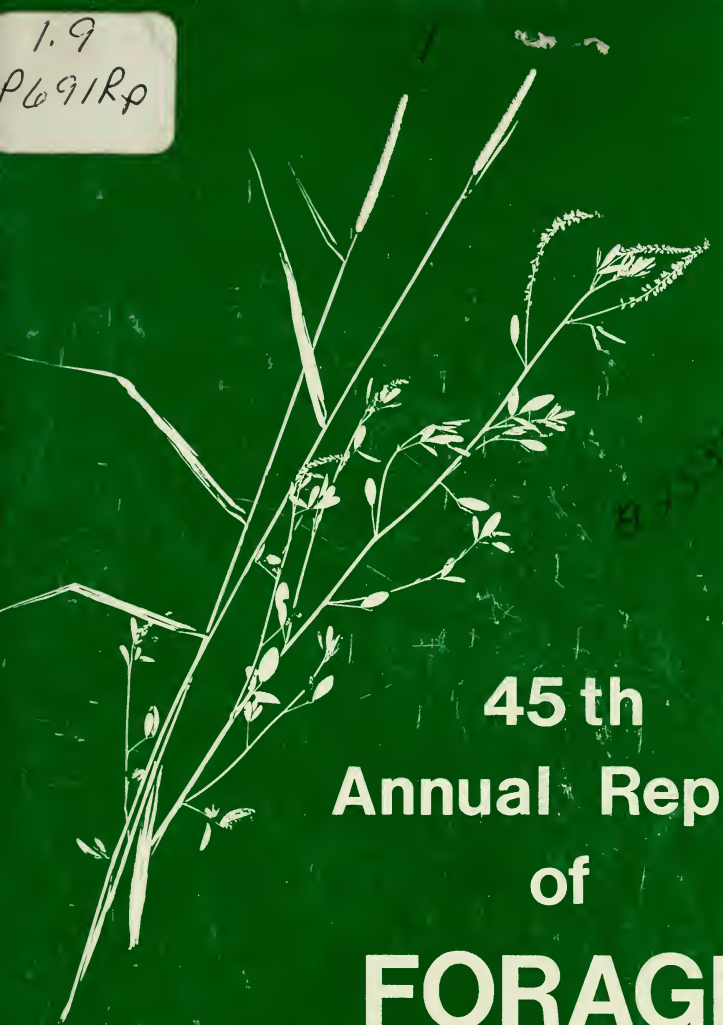


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Annual Report
of
**FORAGE
RESEARCH**
in Northeastern
United States
1981

FORTY-FIFTH ANNUAL REPORT OF FORAGE RESEARCH
IN NORTHEASTERN UNITED STATES
1981

A Joint Contribution of the
U.S. REGIONAL PASTURE RESEARCH LABORATORY
and
BELTSVILLE AGRICULTURAL RESEARCH CENTER
and
AGRICULTURAL EXPERIMENT STATIONS
OF THE 12 NORTHEASTERN STATES

Participating Agencies
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PREFACE

This report is intended, primarily, for use by forage research and extension personnel in Northeastern United States. Included are highlights of forage research activities at the agricultural experiment stations in the region and those of the North Atlantic Area; Northeastern Region, Agricultural Research Service, and Beltsville Agricultural Research Center, U.S. Department of Agriculture.

Appreciation is extended to the scientists and others whose contributions made the report possible. The assistance of Mrs. Teri-Anne Jordan in assembling, retyping, and preparing the report is gratefully acknowledged.

Continuing support and contributions from forage scientists of the region are solicited and encouraged to make the report as valuable as possible. We shall appreciate continuing assistance in obtaining names of newly-arrived forage researchers, transfers, and retirees in the region to keep our records and mailing lists current. Suggestions concerning improvement and desirable changes will be appreciated.

William C. Templeton, Jr.
William C. Templeton, Jr.
Director, U.S. Regional
Pasture Research Laboratory



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Stout, W.L. (104)

Stringer, W.C. (70, 91, 93)
Stutz, J.C. (30)
Subali, S. (11)

T

Taylor, L.C. (40)
Templeton, W.C., Jr. (75,
87, 91, 100, 101, 102)
Thayne, W.V. (13)
Tyrrell, H.F. (92, 97)

V

Vandersall, J.H. (69, 92,
108)
Van Eys, J.E. (84)
Viands, D.R. (8)
Vona, L.C. (85)
Vough, L.R. (9, 47, 48, 54,
55, 66, 69, 92)

W

Wakefield, R.C. (57, 58)
Waldo, D.R. (83, 88)
Walker, C.K. (95)
Wangsness, P.J. (96)
Washer, R.L. (49)
Washko, W.W. (10, 53, 55)
Weaver, J.E. (20)
Weil, R.R. (54)
Welch, J.G. (99)
Welch, R.M. (35)
Westerhaus, M.O. (100)
Wohlt, James (86)
Wood, G.M. (6, 38)

Z

Zaprzalka, J. (47)
Zeiders, K.E. (27, 29)

ROSTER OF RESEARCH AND EXTENSION WORKERS IN
NORTHEASTERN UNITED STATES WITH FORAGE
CROPS AND GRASSLANDS ORIENTATION

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
UNIVERSITY OF CONNECTICUT, Storrs, 06268		
Allison, D.W.	Forage Management	Plant Science
Dest, W.M.	Weed & Turf Invest.	Plant Science
Griffin, G.F.	Soil Fertility	Plant Science
Peters, R.A.	Weed Investigations	Plant Science
Washko, W.W.	Forage Management	Plant Science
Wengel, R.W.	Soil Physics	Plant Science
UNIVERSITY OF DELAWARE, Newark, 19711		
Carroll, R.B.	Plant Pathology	Plant Science
Fowler, R.E.	Beef Cattle Nutrition	Anim. Sci. & Agr. Biochemistry
Haenlein, G.F.W.	Nutritive Evaluation	Anim. Sci. & Agr. Biochemistry
Jones, E.R.	Forage Management	Delaware State Coll.
Mitchell, W.H.	Forage Management	Plant Science
Reitnour, C.M.	Equine Physiology	Anim. Sci. & Agr. Biochemistry
UNIVERSITY OF MAINE, Orono, 04469		
Hall, R.G.	Agronomy	Plant & Soil Sci.
Rowe, R.J.	Engr. Harvesting	Agr. Engineering
Stafford, R.F.	Agronomy	Plant & Soil Sci.
Stokes, M.R.	Ruminant Nutrition	Anim. & Vet. Sci.
UNIVERSITY OF MARYLAND, College Park, 20742		
Decker, A.M., Jr.	Forage Management	Agronomy
Erdman, R.A.	Dairy Nutrition	Dairy Science
Hartsock, T.G.	Animal Nutrition	Animal Science
Kern, D.L.	Animal Nutrition	Animal Science
Ritter, R.L.	Weed Science	Agronomy
Vandersall, J.H.	Dairy Nutrition	Dairy Science
Vough, L.R.	Forage Management	Agronomy

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
UNIVERSITY OF MASSACHUSETTS, Amherst, 01003		
Bhowmik, P.C.	Weed Science	Plant & Soil Sci.
Fenner, Heinrich	Animal Nutrition	Vet. & Anim. Sci.
Herbert, S.J.	Agronomy	Plant & Soil Sci.
Poos, M.I.	Ruminant Nutrition	Vet. & Anim. Sci.
Prange, Robert	Ruminant Nutrition	Vet. & Anim. Sci.
Tritschler, J.P.	Ruminant Nutrition	Vet. & Anim. Sci.

UNIVERSITY OF NEW HAMPSHIRE, Durham, 03824

Dunn, G.M.	Forage Genetics	Plant Science
Estes, G.O.	Forage Nutrition	Plant Science
Frick, G.E.	Agr. Economics	E.S.C.S.
Holter, J.B.	Dairy Nutrition	Animal Science
Koch, D.W.	Forage Plant Phys.	Plant Science
Mitchell, J.B.	Forage Management	Plant Science
Schwab, C.G.	Dairy Nutrition	Animal Science

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY, New Brunswick, 08903

Duell, R.W.	Highway Vegetation	Soils & Crops
Evans, J.L.	Animal Nutrition	Animal Science
Flannery, R.L.	Soils	Soils & Crops
Funk, C.R., Jr.	Turfgrass Breeding	Soils & Crops
Ilnicki, R.D.	Weed Control	Soils & Crops
Justin, J.R.	Farm Crops	Soils & Crops
Markus, D.K.	Soils	Soils & Crops
Meade, J.A.	Weed Control	Soils & Crops
Race, S.R., Jr.	Forage Insects	Ent. & Econ. Zoology
Sprague, M.A.	Manag. & Preservation	Soils & Crops

CORNELL UNIVERSITY (New York), Ithaca, 14853

Duke, W.B.	Weed Control	Agronomy
Fick, G.W.	Forage Phys. & Manag.	Agronomy
Kubota, Joe	Soil Classification	Agronomy
Linscott, D.L.	Weed Control	Agronomy (USDA-ARS)
Lowe, C.C.	Genetics & Breeding	Plant Breeding & Biometry
Millar, R.L.	Forage Diseases	Plant Pathology
Pitt, R.E.	Agr. Engineering	Engineering (Agr.)
Seaney, R.R.	Forage Management	Agronomy
Van Soest, P.J.	Animal Nutrition	Animal Science
Viands, D.R.	Genetics & Breeding	Plant Breeding & Biometry

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
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U.S. PLANT, SOIL, AND NUTRITION LABORATORY, U.S. Department of Agriculture, Agricultural Research Service, Northeastern Region, North Atlantic Area, Tower Road, Ithaca, New York, 14850

Cary, E.E.	Chemistry	Nutrition Lab
Grunes, D.L.	Soils & Plant Nutrition	Nutrition Lab
Welch, R.M.	Plant & Anim. Nutrition	Nutrition Lab

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION, Geneva, 14456

Alconero, R.	Plant Pathology	Plant Introduction (USDA-ARS)
Dolan, D.D.	Plant Introduction	Plant Introduction (USDA-ARS)
Fiori, B.J.	Entomology	Entomology (USDA-ARS)
Sherring, W.R.	Seed Technology	Seed Investigations

THE PENNSYLVANIA STATE UNIVERSITY, University Park, 16802

Ace, D.L.	Dairy Extension	Dairy & Anim. Sci.
Adams, R.S.	Dairy Extension	Dairy & Anim. Sci.
Bartlett, H.D.	Agr. Engineering	Agr. Engineering
Baylor, J.E.	Pasture & Forage Crops	Agronomy
Bloom, J.R.	Nematode Control	Plant Pathology
Buckalew, J.M.	Dairy Science	Dairy & Anim. Sci.
Burdette, L.A.	Anim. Nutrition Ext.	Dairy & Anim. Sci.
Card, C.S.	Animal Health	Veterinary Science
Cash, E.H.	Animal Nutrition	Dairy & Anim. Sci.
Cleveland, R.W.	Genetics & Breeding	Agronomy
Cowan, R.L.	Animal Nutrition	Dairy & Anim. Sci.
Downs, W.G., III	Forage Management	Agronomy (P.O. Rector)
Dum, S.A.	Farm Manag. Ext.	Economics
Fox, R.H.	Soil Fertility	Agronomy
Harpster, H.W.	Animal Science	Dairy & Anim. Sci.
Hartwig, N.L.	Weed Control	Agronomy
Hershberger, T.V.	Animal Nutrition	Dairy & Anim. Sci.
Hower, A.A., Jr.	Forage Insects	Entomology
Johnson, M.W.	Corn Breeding	Agronomy
Kesler, E.M.	Dairy Science	Dairy & Anim. Sci.
Kjelgaard, W.L.	Agr. Engineering	Agr. Engineering
Knievel, D.P.	Forage Physiology	Agronomy
Lanyon, L.E.	Soil Fertility	Agronomy
Long, T.A.	Animal Nutrition	Dairy & Anim. Sci.
Lukezic, F.L.	Forage Pathology	Plant Pathology
McKee, G.W.	Crop Ecology	Agronomy

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
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THE PENNSYLVANIA STATE UNIVERSITY (Continued)

Merritt, T.L.	Animal Science	Dairy & Anim. Sci.
Muller, L.D.	Dairy Science	Dairy & Anim. Sci.
Partenheimer, E.J.	Agr. Economics	Agr. Econ. & Rural Soc.
Risius, M.L.	Genetics & Breeding	Agronomy
Shenk, J.S.	Forage Grass Breeding	Agronomy
Starling, J.L.	Genetics & Breeding	Agronomy
Stringer, W.C.	Forage Management	Agronomy
Wangness, P.J.	Animal Nutrition	Dairy & Anim. Sci.
Wilson, L.L.	Animal Science	Dairy & Anim. Sci.

UNIVERSITY OF RHODE ISLAND, Kingston, 02881

Wakefield, R.C.	Forage Management	Plant & Soil Sci.
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UNIVERSITY OF VERMONT, Burlington, 05405

Bancroft, R.	Feeding Systems Econ.	Agr. & Resource Econ.
Bull, L.S.	Nutritional Value	Animal Science
Gotlieb, A.R.	Plant Pathology	Plant & Soil Sci.
MacCollom, G.B.	Entomology	Plant & Soil Sci.
Murphy, W.M.	Crops & Forages	Plant & Soil Sci.
Parker, B.L.	Entomology	Plant & Soil Sci.
Saenger, P.	Non-Ruminant Nutrition	Animal Science
Way, W.A.	Crops & Forages	Plant & Soil Sci.
Welch, J.G.	Nutritional Value	Animal Science
Wildman, E.E.	Animal Nutrition	Animal Science
Wood, G.M.	Forage Crops	Plant & Soil Sci.

WEST VIRGINIA UNIVERSITY, Morgantown, 26506

Baker, B.S.	Forage Management	Allegheny Highlands Project (Elkins)
Balasko, J.A.	Forage Physiology	Plant Science
Bennett, O.L.	Forage Management	Plant Science (USDA-ARS)
Bryan, W.B.	Forage Management	Plant Science
Butler, Linda	Entomology	Plant Science
Keefer, R.F.	Soil Fertility	Plant Science
Lewis, P.E.	Animal Nutrition	Anim. & Vet. Sci.
Prigge, E.C.	Animal Nutrition	Anim. & Vet. Sci.
Reid, R.L.	Animal Nutrition	Anim. & Vet. Sci.
Ulrich, V.	Plant Breeding	Plant Science

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
BELTSVILLE AGRICULTURAL RESEARCH CENTER, U.S. Department of Agriculture, Agricultural Research Service, Northeastern Region, Beltsville, Maryland, 20705		
Bond, James	Animal Science	Ruminant Nutr. Lab
Calvert, C.C.	Animal Science	Non-Ruminant Anim. Nutr. Lab
Carlson, G.E.	Forage and Range	National Prog. Staff
Coulson, J.R.	Entomology	Benef. Insect Intro. Lab
Dudley, R.F.	Agr. Engineering	Agr. Engineering
Elden, T.C.	Entomology	Field Crops Lab
Elgin, J.H., Jr.	Agronomy	Field Crops Lab
Faust, R.M.	Entomology	Insect Pathology Lab
Feldmesser, J.	Zoology	Nematology Lab
Foy, C.D.	Soil Science	Plant Stress Lab
Glenn, Barbara	Animal Science	Ruminant Nutr. Lab
Hayes, D.K.	Chemistry	Livestock Insect Lab
Hodges, R.W.	Entomology	Systematic Ent. Lab
Hoooven, N.W., Jr.	Animal Science	Animal Operations
Howell, R.K.	Plant Pathology	Plant Stress Lab
Keys, J.E., Jr.	Animal Science	Milk Secretion & Mastitis Lab
Kulik, M.M.	Plant Pathology	Seed Research Lab
Lentz, P.L.	Botany	Mycology Lab
Lynch, G.P.	Animal Science	Ruminant Nutr. Lab
Moe, P.W.	Animal Science	Ruminant Nutr. Lab
Murray, J.J.	Agronomy	Field Crops Lab
Norris, Karl	Laboratory Chief	Instrumentation Res.
Oakes, A.J.	Agronomy	Germplasm Resources Lab
O'Neill, N.R.	Plant Pathology	Field Crops Lab
Ostazeski, S.A.	Plant Pathology	Field Crops Lab
Owens, L.D.	Plant Physiology	Plant Nutr. Lab
Ratcliffe, R.H.	Entomology	Field Crops Lab
Reeves, J.B.	Chemistry	Ruminant Nutr. Lab
Reynolds, P.J.	Animal Science	Ruminant Nutr. Lab
Rumsey, T.S.	Animal Science	Ruminant Nutr. Lab
Schroder, R.F.	Entomology	Benef. Insect Intro. Lab
Simpson, M.E.	Plant Pathology	Ruminant Nutr. Lab
Slyter, L.L.	Chemistry	Ruminant Nutr. Lab
Smith, L.W.	Animal Science	Biol. Waste Manag. Lab
Snyder, F.W.	Plant Physiology	Light & Plant Growth Lab
Terrell, E.E.	Botany	Plant Taxonomy Lab

<u>Name</u>	<u>Field of Interest</u>	<u>Department</u>
BELTSVILLE AGRICULTURAL RESEARCH CENTER (Continued)		
Tyrrell, H.F.	Animal Science	Ruminant Nutr. Lab
Waldo, D.R.	Animal Science	Ruminant Nutr. Lab
White, G.A.	Laboratory Chief	Germplasm Resources Lab
Yaklich, R.W.	Plant Physiology	Seed Research Lab

U.S. REGIONAL PASTURE RESEARCH LABORATORY, U.S. Department of Agriculture, Agricultural Research Service, Northeastern Region, North Atlantic Area, University Park, Pennsylvania, 16802

Templeton, W.C., Jr.	Forage Crops Ecology	Director
Abrams, S.M.	Ruminant Nutrition	
Berg, C.C.	Genetics (Grasses)	
Byers, R.A.	Forage Insects	
Fissel, G.W.	Chemistry	
Gustine, D.L.	Biochemistry	
Hill, R.R., Jr.	Genetics (Alfalfa)	
Jung, G.A.	Forage Management	
Kendall, W.A.	Plant Physiology	
Leath, K.T.	Pathology (Legumes)	
Moyer, B.G.	Plant Pathology	
Shaffer, J.A.	Soils	
Sherwood, R.T.	Pathology (Grasses)	
Stout, W.L.	Soils	
Zeiders, K.E.	Plant Pathology	

SECTION I

BREEDING, GENETICS, AND PLANT
INTRODUCTION RESEARCH

Title: Breeding Alfalfa for Disease and Insect Resistance

Leaders: J.H. Elgin, Jr., S.A. Ostazeski, T.C. Elden, and
R.H. Ratcliffe (Beltsville Agricultural Research
Center)

Cycle 3 screening of 14 Beltsville germplasm pools for resistance to race 1 and race 2 of the anthracnose-causing fungus Colletotrichum trifolii has been completed. Evaluation of resistance levels attained in each population is now underway.

An inheritance study to investigate the differing genetic systems that condition only resistance to race 1 in Arc vs resistance to both race 1 and race 2 in Saranac-AR has been initiated.

Third-cycle screening of 2-week-old seedlings of Arc and Bl6 alfalfa for resistance to adult potato leafhopper feeding has been completed. Second-cycle screening of two additional populations, BMP8 and W10, has also been completed. Evaluation of the progress in the selecting process is underway.

Twenty-eight primitive cultivars were collected in Turkey in 1981 and are presently being evaluated in the laboratory for resistance to alfalfa weevil larval feeding. Because alfalfa and the weevil have coexisted in eastern Turkey for hundreds of years, it is speculated that some of the primitive cultivars used there might carry greater resistance to the weevil than we have in our present-day cultivars.

Title: Field Evaluation of Perennial Ryegrass Cultivars for
Billbug Resistance

Leaders: C.R. Funk, Jr., S. Ahmad, and W.K. Dickson (Rutgers
University)

Severe damage from billbugs (Sphenophorus parvulus Gyllenhal) was observed on replicated turf trials of perennial ryegrasses. Some cultivars and selections showed substantial resistance, whereas others were heavily damaged. Pennant and Regal showed the best resistance of the commercially available ryegrasses. Percent damage estimates of representative cultivars were: Pennant 3%, Regal 4%, Pennfine 17%, Dasher 18%, Manhattan 22%, Blazer 28%, Linn 29%, Fiesta 32%, Diplomat 36%, S-321 37%, Loretta 38%, Citation 39%, Omega 40%, Yorktown II 49%. The LSD at 5% was 14%.

Title: NE-9: Introduction, Testing, Multiplication, and Preservation of Potentially Valuable Plants for Crop Improvement and Industrial Use

Leaders: D.D. Dolan and W.R. Sherring (Northeast Regional Plant Introduction Station)

Forage Legume Introductions

Red Clover (Trifolium pratense) and White Clover (Trifolium repens)

A paper on the evaluation of both red and white clover introductions was presented at the meeting of the Northeastern Branch of the American Society of Agronomy at Orono, Maine, on July 13-14, 1981. An abstract of the article follows:

Most of the 34 red and 66 white clover introductions were from a Japanese collection, and the test was continued into the second year. The dry matter yields were taken in the second year. There were three replicates of each introduction. Individual plots were single rows, 1.2 m apart and 3.7 m long. The design was a randomized complete block. No introduction yielded as high as the two standard cultivars, Lakeland and Kenland. Both gave approximately 166 g of dry matter per plant. The highest plant introduction gave 121 g of dry matter/plant. The yields of 15 other introductions are given. These were all from Japan and ranged in number from PI 419547 to 419557.

The dry matter yields of the white clover introductions from the highest to the lowest are as follows: PI 419973, 419996, 420000, 420011, 419580-85, 42004, 419993, 419998, 419997, 419974, 420010, 420015, 420016, 419986, and 419577.

The 1981 clover planting at Geneva consisted of 48 introductions of Trifolium pratense, one of T. alpestre, 12 introductions of T. canescens, one of T. heldreichianum, 15 introductions of T. medium, one of T. rubens, and four introductions of Trifolium species. The seedlings were started in the greenhouse, seeded on March 15, 1981, and set in the field on April 25, 1981. There were 20 plants of each accession, and these were set in each of two replicates. The rows were spaced 4 ft apart and the plants 1 ft apart in the row. Beginning on July 15 and continuing through August 24, notes were taken on type--medium or mammoth; uniformity; plant habit; vigor; plant size; number of stems; stem size; leafiness; earliness of maturity; number of heads set; damage due to various diseases; fall recovery; winter hardiness; and spring recovery.

According to the ratings, the most promising red clover introductions were: PI 189173, 418829, 418883, 418885, and 419294.

The most promising introduction of T. hybridum was PI 184551.

The most promising introductions of zigzag clover (T. medium) were PI 241117 and 325498.

Birdsfoot Trefoil (Lotus corniculatus)

A planting of 40 birdsfoot trefoil introductions set out in 1980 was in its second growing season during 1981. In the interval June 29 to October 14 notes were taken on the following descriptors: uniformity; plant habit; plant vigor; plant size; number of stems; stem size; leafiness; size of leaves; color of leaves; flower color; amount of pods set; earliness of maturity of pods; fall recovery after cutting; winter hardiness; and spring recovery.

Trefoil introductions that rated well according to this evaluation system and should be further evaluated are: PI 285283, 300014, 303817, 340799, 404347, 404788, 404789, 418815-18, 419233, 430301, 430542-48, and 433923.

Forage Grass Introductions

Timothy (Phleum pratense)

At the meeting of the Northeastern Branch, American Society of Agronomy at Orono, Maine, July 13-14, 1981, a paper was presented entitled "The Evaluation and Dry Matter Yields of Japanese Timothy Introductions at Two Locations--Big Flats, N.Y., and Geneva, N.Y." The abstract is as follows:

Seedlings of 75 introductions of Japanese timothy were started in the greenhouse in the spring of 1979. Two plants, each with three replicates, were set out at Geneva, N.Y., and at Big Flats, N.Y. Each plot was a single row having 16 plants at least 1 ft apart. During 1980, the second year of the planting, green weight yields were taken on the center 14 plants in each plot. Each plot was cut when one-fourth of the plants were in bloom. Harvested forage was immediately taken to a field house and green weights recorded. The five highest yielding introductions are as follows: PI 419824, 419743, 419683, 419759, and 419792. All of these five yielded in the vicinity of 3.40 to 3.50 kg of green weight per plot. The yields of 10 other Japanese introductions and the standard cultivars are also given. The 10 other promising Japanese timothyes are as follows: PI 419821, 419819, 419864, 419789, 419842, 419875, 419856, 419717, and 419741.

The project of screening timothy introductions for individual plants that have the capacity to thrive under high ammonium nutrition was continued in 1981. A manuscript has been prepared and is being submitted for publication early in 1982.

On June 15, photographs of the most promising individual plant selections in the high-ammonium study were made. The numbers of these selections are as follows: G-26045, 26052, 26054-56, and 26058.

On September 25, 1981, we took photographs of two timothy introductions in the 1981 planting that appeared very promising and equivalent to the cultivar Essex FC 36616. These two promising introductions are PI 386168 (Denmark) and 406322 (USSR).

On the same date, we took photographs of four promising introductions of the species Phleum pheloides. The four are: PI 206714 (Turkey), 440588 (USSR), 440590 (USSR), and 440593 (USSR). This is the first time that we recall seeing such attractive introductions of this species.

Tall Oatgrass (Arrhenatherum elatius)

On September 15, photographs were taken of four introductions of tall oatgrass that appear unusually promising. These were first set out in 1981 and are: PI 249719 (Greece), 288923 (Hungary), 302849 (Spain), and 338629 (Morocco).

On the same date, we found a promising introduction of Arrhenatherum erianthum--PI 245729 (Turkey).

Title: Evaluation of Timothy Introductions from Japan

Leader: G.M. Wood (University of Vermont)

Seventy-six Japanese timothy introductions, planted in replicated rod rows, were compared with common, Climax, and Champlain as check varieties during 1980 and 1981. Six Japanese introductions exceeded Champlain in seasonal yield by 10% or more, with PI 419839 being 16% higher.

All entries were rated for seedling and spring vigor, uniformity, pest resistance, leafiness, date of heading, and habit of growth. Highest yielding PI 419839 was in full head on June 21 as compared to June 9 for common, June 18 for Climax, and June 26 for Champlain. Only one of the six highest yielding timothyes, PI 419813, headed as early as common. The other high yielding introductions were within 4 days (plus or minus) of the heading date for Climax. Almost half of the introductions

did not bloom by the late first cut of July 7 in 1980, although some of these did achieve early boot. When the second cut was made in 1980 on September 8, two-thirds were in full head, some for the first time.

A few introductions were of a creeping type and appeared to be Phleum nodosum. There was essentially no winter injury in either 1980 or 1981, even though 1981 was a "test" winter. Twenty-one of the introductions showed crazy top symptoms, indicating the presence of "down" mildew, Sclerospora graminicola. None of the three American checks appeared to be infected. Yield appeared to be relatively unaffected by the disease. Spittlebug, Philaenus spumarius (L.), occurred in significant numbers only in 1981. Leafy types appeared to be infected more with spittlebug than less leafy types.

During 1980, none of the accessions were higher yielding than check cultivars; however, in 1981, 15 accessions outyielded or equaled check cultivars.

Some differences were noted in ratings for seedling and spring vigor, but most accessions were vigorous in both categories.

Title: Field Evaluation of Perennial Ryegrass Cultivars for Sod Webworm Reaction

Leaders: C.R. Funk, Jr., and G. Mazur (Rutgers University)

Severe damage from sod webworm larvae was observed on turf trials of perennial ryegrasses during the abnormally dry months of August, September, October, and November 1980 at the Soils and Crops Research Center at Adelphia, N.J. Large differences were observed in foliage damage and larval density between cultivars. Pennant perennial ryegrass and a number of experimental selections showed substantially less damage than any of the other named cultivars in this test. Percent damage and larval counts for some typical cultivars are:

<u>Cultivar</u>	<u>Percent Damage</u>	<u>Larvae per 100 sq cm</u>
Pennant	18	0.7
Linn	91	4.9
Premier	72	9.2
Manhattan	88	9.5
Pennfine	84	11.9
Yorktown II	84	12.1
Derby	84	13.8
LSD at 5%	13	2.8

Title: Breeding Cool-Season Forage Species for Improved Feeding Value and Productivity

Leaders: C.C. Lowe and D.R. Viands (Cornell University)

Previous studies on quality selection in alfalfa indicate the major procedure problem lies in adequate sampling to represent total season production of genotypes. This usually includes three growth cycles per season. An extensive sampling study was continued in 1981 using a replicated field trial containing adapted varieties and synthetics derived from quality-selected parents. Two year's results show consistency in rank for protein content of genetic populations when sampling error effects are nullified by extensive sampling. Rank for protein is relatively constant between seasons and between growth cycles within seasons. Populations vary in rank, however, for fiber content in different growth cycles. This variation within seasons appears to be consistent between seasons. The pattern of fiber content variation suggests association with growth patterns and relative maturity classification of the populations. This information should influence requisite sampling procedures. For protein, sampling in a single growth cycle may be adequate for genotype differentiation, but this may not be adequate to reflect total season differences for other quality criteria.

Breeding programs have been initiated on alfalfa to add Verticillium wilt and Fusarium root rot resistance to current adapted New York germplasms. Verticillium was identified in several parts of New York in 1981. Crosses to resistant sources and disease screening are in progress. Four hundred isolates of Fusarium collected from New York fields are being classified and will be used to develop resistant alfalfa germplasms. Significant genetic variation has been found in alfalfa for root regeneration ability. This is being studied for possible effects on disease tolerance and productivity.

Title: Improvement of Forage Quality in Alfalfa by Breeding

Leaders: C.C. Lowe and D.R. Viands (Cornell University)

Selection for improved alfalfa quality was continued using ADF and dye binding assay procedures to indicate fiber and protein content. Seven source populations of varied origin have been advanced through the first selection cycle and survivors used as parents for second-cycle source populations. Two second-cycle populations were screened for quality in 1981; the rest are in the preliminary rigid selection phase for agronomic desirability which precedes quality assay.

Evaluation of production and quality for several synthetics derived from first selection cycle parents was continued over a second production season in 1981. Results continue to indicate that average protein and fiber content for the total season production can be altered without reduction in the yield or vigor level exhibited by present adapted varieties. The synthetic demonstrating this is from a source population derived from two-thirds adapted variety germplasm and one-third from previously unused Medicago species. It is uncertain whether the exotic germplasms have really extended genetic variation for quality criteria. Synthetics will be produced for all second-cycle populations to evaluate breeding progress.

Title: Red Clover Variety Trials

Leaders: A.M. Decker, L.R. Vough, T.H. Miller, and J.H. McNemar
(University of Maryland)

A new seeding of 16 red clover varieties and strains was seeded April 28, 1981. Even though a preemergence herbicide was used, weed invasion was rather severe. Pigweed was a major problem early in the season, and annual weedy grass invasion was severe during the latter part of the season. As a result, yields were not obtained during the establishment year. Fair to excellent stands exist at the end of the 1981-82 winter period. The best stands are in the Chesapeake plots at this time. Yields will be determined during the 1982 growing season.

Title: Yield and Longevity Evaluations of Alfalfa Cultivars

Leaders: L.R. Vough, J.H. McNemar, A.M. Decker, and T.H. Miller
(University of Maryland)

Project objectives are to evaluate alfalfa cultivars for yield and stand persistence. Evaluations of trials established in 1976 and 1978 were continued in 1981. The entries Olympic, Atlas, Vorris A-77, Vanguard, Saranac-AR, and WL 311 have rather consistently been the top yielding cultivars over the 6 years of evaluation of cultivars established in 1976. Performance of Phytophthora root rot resistant cultivars has improved as the stand life increases. Phytophthora root rot symptoms have been observed in fields 2 of the last 3 years, and there was evidence of Phytophthora within the plot area itself in 1979.

Only 3 years of data are available for the trial established in 1978. Several more years of data are needed in this trial to determine which cultivars will be consistently high in yield and have the best persistence.

Title: Breeding Tall Fescue for Tolerance to Acid-Soil Conditions

Leaders: J.J. Murray and C.D. Foy (Beltsville Agricultural Research Center)

Intercrosses were obtained among plants within the first and second cycle of recurrent selection and the source populations, and among tolerant and sensitive plants selected from advanced breeding clones. In nutrient solution tests, cultivars expressing tolerance to acid, Al-toxic Tatum soil, were also more tolerant to Al in solution. Acid-tolerant cultivars raised the pH (reduced the solubility of Al) of nutrient solutions.

Title: Breeding Tall Fescue for Netblotch Resistance

Leaders: J.J. Murray and N.R. O'Neill (Beltsville Agricultural Research Center)

Tall fescues selected in laboratory tests for resistance to Dreschlera dictyoides were intercrossed in field isolation blocks. A sufficient seed supply was obtained to establish evaluation plots and for the second cycle of selection.

Histological examination of events following penetration by D. dictyoides conidia suggests that the moderate levels of resistance identified in some clones of tall fescue are operating at the cellular level. Thirty percent fewer subepidermal vesicles were formed following initial spore penetration into moderately resistant leaf tissue as compared to tissue from susceptible clones.

Title: Evaluation of Cultivars for Forage Production

Leader: W.W. Washko (University of Connecticut)

Forage productivity of cultivars of alfalfa, red clover, orchardgrass, and timothy developed in private and public programs continues in field studies at the Storrs location.

Among named red clover cultivars, Florie, Florex, Prosper I, Arlington, and Tristan have consistently produced above mean yields under a three cutting annual harvest schedule. Red clover rarely persists into a third harvest year at this location, and new releases show no improved longevity.

Title: Breeding Red Clover and Alfalfa (Project PENO 2290 and 2251)

Leaders: R.W. Cleveland, M.L. Risius, and J.S. Shenk
(The Pennsylvania State University)

Alfalfa and red clover field experiments for variety evaluations were conducted at Landisville, Pa. (southeastern) and Rock Springs, Pa. (central area). Anthracnose disease continued to be an important factor on the performance of alfalfa varieties at both locations. Northern and southern anthracnose were important diseases affecting red clover forage yields, and varieties showed marked differences in reactions to these diseases. Most red clover varieties that have been recently released (within last 5 years, approximately) for use in the Northeast are markedly superior to old red clover varieties in yield. Lesser disease effects are probably responsible for better yield.

New plantings of red clover and alfalfa field experiments were made at the same locations for future forage yield evaluation.

Northern anthracnose (NA) disease was evaluated in red clover populations after artificial inoculations of greenhouse cultures. Population studied was previously selected for resistance to southern anthracnose. A new population not previously selected for disease was also evaluated for NA. Seed was produced on selected plants in field isolation for continuation of breeding. Creeping alfalfa plants were tested for seed production under bee pollination in a greenhouse. Plants with satisfactory seed production were isolated from a population that had previously been evaluated as seriously deficient in production. Outside germplasm was introduced into population in an attempt to improve seed setting. Field testing of earlier stages of creeping populations was continued. Creeping lines evaluated show moderate promise of agricultural use and further work seems justified.

Title: Evaluation of Timothy Introductions

Leaders: S. Subali and W.B. Bryan (West Virginia University)

Eighty-two timothy cultivars, 75 accessions from Japan and seven standard U.S. varieties (Toro, Itasca, Champlain, Timfor, Common (2), and Climax) were evaluated in 1980 and 1981 at a high altitude in northern West Virginia. Weather was normal for the area. There were 180 frost-free days in 1980; mean monthly temperatures were 20.5 for July and -6.6 for January 1981. Precipitation for 1980 was 1,478 mm, with 149 cm of snow in the winter 1980-81. All cultivars were very winter hardy.

Fifteen accessions were very well adapted and better than the standards. Eleven accessions in 1980 and 17 in 1981 were classified as very disease resistant. Four accessions were very early maturing (June 17), 34 early, 28 late, and 9 very late (July 14). Most of the standards were early maturing. Climax was the highest yielding standard. Accessions PI 419680, 419729, 419791, 419821, 419855, 419792, G-25245, 419861, 419842, 419822, and 419837 outyielded Climax. The lowest yielding was the stoloniferous PI 372628. Most of the accessions exhibited hay-type traits. Accession PI 419717, 419813, 419816, and 419849 were very early maturing, tall upright plants. Later maturing, more leafy, prostrate plants were PI 419672, 419873, 372628, and 419875.

Title: Forage-Livestock Systems for Land with Soil and Site Limitations

Leaders: M.A. Sprague and Cynthia Rosenzweig (Rutgers University)

NE-114 plantings of warm-season grasses on August 16, 1978, were evaluated for their establishment, survival, and apparent usefulness on light sandy loam soils in central New Jersey. Caucasian bluestem was far superior to Blackwell switchgrass, big and little bluestem in late summer 1981, with respect to ground covered, leafiness, and yield.

Crimson clover varieties showed excellent winter survival and yielded from 5.9 to 6.9 tons of dry forage per hectare on May 27, 1981. Of the subterranean clovers, Nangeela, Mt. Barker, and Woogenellup showed good cold tolerance in laboratory freezing tests and yields ranging from 2.2 to 2.8 tons/ha. Tallarook, Mississippi Ecotype, and Geraldton demonstrated less cold tolerance and yields from 0.8 to 1.5 tons. Kondinin and Wilton rose clovers survived the winter well and yielded 3.4 and 4.4 tons, respectively. Olympus and Sirint showed no winter survival.

These and other varieties of subterranean clovers were sown in August 1981 for more detailed evaluations of their respective capacity for cold tolerance.

Title: Heterosis in Half-Sib Parental Line Crosses of Alfalfa

Leader: R.R. Hill, Jr. (U.S. Regional Pasture Research Laboratory)

A partial diallel cross of alfalfa with 32 half-sib lines as parents was evaluated for yield in 1980 and 1981. The parental lines were derived from Appalachee, Arc, MSA, and MSB alfalfa (eight from each population). Progeny from the intercross of each of the parental lines were also included in the experiment.

Significant mean squares for cultivars from which the parental lines were derived and for lines in cultivars were observed for the intercrosses of the parental lines and for general combining ability. In both cases, the mean square for cultivars was more than 20 times larger than the mean square for lines within cultivars. The only specific combining ability was the component due to cultivars. Interactions between genetic effects and years generally were not significant.

Crosses had significantly greater yield than the mean of the parental line intercrosses for each of the cultivar combinations. Generally, crosses with lines from MSA and MSB as one of the parents yielded significantly less than crosses between lines from Appalachee and Arc, and crosses between lines from MSA and MSB yielded significantly less than crosses from any other cultivar combination. The intercrosses of parental lines from MSA had greater average yield than those from MSB, but parental lines from MSA had lower combining ability than those from MSB.

Title: Genetic and Environmental Variance of Water-Soluble Carbohydrate Concentration, Yield, and Disease in Tall Fescue

Leaders: J.A. Balasko, D.M. Burner, and W.V. Thayne (West Virginia University)

Tall fescue (*Festuca arundinacea* Schreb.), a widely grown forage in the southeastern U.S., would be more useful as a livestock feed if its energy value in summer were increased. Genetic and environmental variance of water-soluble carbohydrate (WSC) concentration was measured on summer regrowth forage harvested from a population of tall fescue derived from a worldwide collection. Variances of yield and disease ratings were measured also.

Forty-five genotypes of each of 27 foreign accessions and three domestic cultivar accessions were randomly chosen from a source nursery and established in space-planted nurseries at

three locations in West Virginia in 1980. At each location, three blocks contained plants representative of all 30 accessions. In each block, there was a different set of five genotypes of each accession and two replications of each of the five genotypes. There were 300 plants (150 genotypes) in each block. Variance components of WSC concentration, yield, and disease ratings were estimated by equating mean squares to expected mean squares of appropriate analysis of variance models.

Genetic variances of WSC concentration, yield, and disease ratings were 55, 65, and 75% of total variances, respectively, and environmental variances were 42, 36, and 29%, respectively. The area x accession components of the genotype x environment (G x E) interaction variances for WSC concentration, yield, and disease were 2.1, 1.5, and 2.6% of the total variances, respectively. The block x accession within area components of G x E interaction variances were not significant for the three variables. The high degree of genetic variance within the population indicates that there is potential for genetic improvement in all three variables. Under conditions of this experiment, interactions between genotypes and environment were minor and indicate that the potential for wide adaptability exists within the population.

Title: Evaluation of Alfalfa Synthetics Selected for High and Low Phosphorus Concentrations

Leaders: R.R. Hill, Jr., and L.E. Lanyon (U.S. Regional Pasture Research Laboratory and The Pennsylvania State University)

Six two-clone synthetics selected for high phosphorus concentration and four two-clone synthetics selected for low phosphorus concentration were evaluated at two phosphorus fertility levels on farms in Huntingdon and Jefferson Counties in Pennsylvania. Average yield of the high-phosphorus synthetics was not significantly different from that of the low-phosphorus synthetics, but significant variation in yield within the high-phosphorus synthetics was detected. The addition of phosphorus fertilizer increased yields in Huntingdon County but did not in Jefferson County.

Mean phosphorus concentration of the high-phosphorus synthetics was significantly greater than that of the low-phosphorus synthetics. The addition of phosphorus fertilizer significantly increased phosphorus concentration in the synthetics, and the difference between the high- and low-phosphorus synthetics was greater at the high fertility than at the low.

Title: Genotype x Environment Interaction Analysis of an Alfalfa Trial

Leaders: R.R. Hill, Jr., and J.E. Baylor (U.S. Regional Pasture Research Laboratory and The Pennsylvania State University)

A trial with 49 entries of alfalfa was evaluated for total season yield under two harvest managements for 3 years (1979 to 1980) at each of two locations (Rock Springs and Hershey). Three methods of genotype x environment interaction analysis were applied to the data: (a) routine multifactor analysis of variance with locations, managements, years, and entries as main effects as described in chapter 14 of Cochran and Cox (Experimental Designs, 2nd. ed., Wiley and Sons, 1957); (b) linear regression of individual entry means on the mean of all entries in each environment as described by Eberhart and Russell (Crop Sci. 6:36-40 (1966)) and as modified by Moll et al. (Crop Sci. 18:641-645 (1978)); (c) an orthogonal contrast analysis that partitioned the variation over environments for each entry into sources due to years, locations, and managements and all possible interactions between these factors.

Entries, all two-factor interactions, and the location x management x entry interaction were significant sources of variation in the analysis of variance. Variation in correlations among pairs of entries was a much more important component of the genotype x environment interaction sum of squares than was variation in responsiveness of entries to environments. Because of the variation in correlations among pairs of entries, the regression analysis did not provide a simple interpretation of the observed responses of genotypes to different environments.

The orthogonal contrast analysis revealed that entries varied in their response to years (age of stand), locations, and managements, and that interactions between various combinations of these factors were present. Entries that increased in yield relative to the average of all entries in the trial as the stand aged all had moderate or higher levels of resistance to anthracnose and Fusarium wilt. Entries that decreased in yield relative to the other entries in the trial were susceptible to one or both of the diseases. Relationships between disease resistance of the entries and responsiveness of the entries to locations or managements were not detected.

We concluded that orthogonal contrast approach to analysis of genotype x environment interaction was more appropriate than the other methods investigated for use with perennial crops such as alfalfa.

Title: In vitro Culture of Cenchrus ciliaris Spikelets

Leaders: D.K. DeGroote and R.T. Sherwood (The Pennsylvania State University and U.S. Regional Pasture Research Laboratory)

A technique was developed for in vitro culturing of Cenchrus ciliaris (Gramineae) spikelets for the purpose of assessing the influence of exogenously supplied synthetic hormones or partially purified fractions from sexual or apomictic genotypes on the mode of reproduction. Differentiation of nucellar cells into aposporous embryo sacs appeared to be closely associated with degeneration of the megagametophyte in an obligately apomictic genotype (Higgins) and a facultatively apomictic line (18-35). Inflorescences of Higgins, 18-35, and an obligately sexual genotype (B-1s) were surface disinfected. Excised spikelets were cultured on Murashige and Skoog basal inorganic salt agar medium with 100 mg myoinositol/L. Stage of development ranged from archesporial to megagametophytic when spikelets were initially cultured. Spikelets collected 6 days later had progressed to mature sexual or aposporous embryo sacs, contingent upon genotype. This technique provides a model system to test the influence of synthetic or naturally occurring moieties on embryo-sac formation in Cenchrus ciliaris.



SECTION II

ENTOMOLOGY RESEARCH



Title: Laboratory Selection for Greenbug Resistance in Kentucky Bluegrass

Leaders: R.H. Ratcliffe and J.J. Murray (Beltsville Agricultural Research Center)

Research was continued in 1981 to evaluate Kentucky bluegrass cultivars for greenbug resistance. A total of 47 cultivars has been screened by the seedling method reported in the 44th Annual Report of Forage Research in Northeastern United States. Approximately 2,000 plants were tested from each cultivar. The frequency of resistant plants in the cultivars tested ranged from 0 to 6%, with about 80% of the cultivars having 1% or less resistant plants. Cultivars with the highest frequency of resistant plants included A-34, Adelphi, Kenblue, Piedmont, Sydsport, South Dakota Common, and Troy. The majority of the plants selected for resistance (625 entries representing 33 cultivars) were established in a space-plant nursery or replicated field trial in June 1981. Plants that were evaluated too late to be included in field studies in 1981 will be placed in the nursery in the spring of 1982. Seventeen greenbug-resistant and three greenbug-susceptible selections were included in the replicated field trial. Selections were increased vegetatively to produce the plants used in this trial. A group of greenbug-susceptible plants were placed between the rows of the test selections and around the borders of each replication to enhance build-up of greenbug populations in the plots. The plots were infested with laboratory-reared greenbugs in late August 1981, but populations did not develop to sufficient levels to evaluate plants for resistance. The study will be infested in 1982 in an effort to obtain field data on greenbug resistance. All selections will be evaluated for agronomic characteristics and response to diseases that occur naturally in the field.

Title: Resistance to Clover Root Curculio in Alfalfa

Leaders: R.A. Byers and W.A. Kendall (U.S. Regional Pasture Research Laboratory)

Thirty-three plant introductions were evaluated for resistance to Sitona hispidulus F. on the slant-board system in the growth chamber. Two entries (PI 277705 and PI 286371) from Italy and Turkey had significantly ($P=0.05$ and $P=0.01$) lower growth indices for larvae than for the red clover check. The remaining introductions which had low ratings of feeding on tap roots at Pullman, Wash., were susceptible in the growth chamber. The two alfalfas showing reduced growth of larvae will be retested to make certain they are resistant.

Title: Control and Bionomical Studies of Livestock and Animal Food Crop Insects in West Virginia

Leaders: Linda Butler, J.E. Weaver, and J.W. Amrine, Jr. (West Virginia University)

Efficacy trials for control of alfalfa insects were conducted on small plots using the compounds Advantage, Baythroid, SIR 8514, and Cymbush. Against alfalfa weevil larvae, Advantage and Baythroid were as effective as Furadan; SIR 8514 was less effective but still provided a significant degree of control of up to 64%. Against potato leafhopper, Advantage, Baythroid, and Cymbush provided excellent control of nymphs (89 to 99%) through 24 days post-treatment and were rated equal to or better than the standard Cygon.

The potentially severe forage pest, Thymelicus lineola (Oschenheimer) (Lepidoptera:Hesperiidae) was collected for the first time in the north-central West Virginia counties of Monongalia and Upshur, thus extending its range west of the mountains.

Title: Laboratory Selection for Potato Leafhopper Resistance in Alfalfa

Leaders: T.C. Elden and J.H. Elgin, Jr. (Beltsville Agricultural Research Center)

Five alfalfa populations have been screened in a laboratory seedling study with a range of one to three cycles of selection. Approximately 7,500 seedlings per population were tested in each cycle. A replicated field study was established in the fall of 1981 consisting of the five populations representing 10 cycles of selection plus checks. A comparison of the five populations and their respective cycle of selection will be made in 1982. Approximately 40 plants from two populations with one cycle of seedling selection have been selected from feeding damage tests and have been crossed as separate populations to create an additional type of selection. These same individual plants were vegetatively propagated in the greenhouse and planted in a replicated field study to be evaluated in 1982. Individual plants from three populations with two cycles of seedling selection are currently being screened in the feeding damage test. Selected plants from each population will be crossed and their progeny planted in the field in the fall of 1982. How these populations with varying cycles of selection perform in the field will indicate whether we are making progress through laboratory selection and which methods are more productive.

Title: Resistance in Alfalfa to a Red Form of the Pea Aphid

Leaders: R.H. Ratcliffe, J.L. Kugler, and J.H. Elgin, Jr.
(Beltsville Agricultural Research Center and W-L
Research, Inc.)

Twenty-two alfalfa lines or cultivars were evaluated in seedling tests for resistance to a red form of the pea aphid collected from alfalfa in Maryland. Of the 19 lines or cultivars tested that have been classified as resistant to the green form of the pea aphid, only the lines BAA-15 and PA-1 and the cultivar CUF-101 exhibited high resistance to the red form. The remaining 16 lines or cultivars, which have moderate to high resistance to the green form of the pea aphid, were susceptible to the red form, although a few resistant plants occurred in each cultivar. At Beltsville, plants resistant to the red form were selected from Arc, Kanza, Team, and Ranger (the susceptible control) and intercrossed to develop two alfalfa populations, B-26 and B-26a. B-26 was developed from an intercross of 168 plants selected from the four cultivars in seedling screening tests. B-26a was developed from an intercross of 75 of the plants contributing to B-26 which expressed resistance both as seedlings and as 1- to 3-month-old plants.

Title: Impact of Slugs and Insects on Establishment of
Alfalfa in Sod and Grain Stubble

Leaders: R.A. Byers and R.L. Mangan (U.S. Regional Pasture
Research Laboratory and The Pennsylvania State
University)

Mowing grain stubble before planting alfalfa in mid-August effectively increased plant density during establishment in September. Insecticides and herbicides applied at planting time had no effect on plant density, with many plots losing 100% of the seedlings. This loss was caused by the slugs, Deroceras reticulatum and D. laeve. Mowed stubble plots had fewest slugs under refuge traps and the most seedlings.

Treating an old alfalfa sod with Roundup, Furadan, and Mesurol bait was the most successful method to establish alfalfa by minimum tillage in June. Untreated plots were complete failures because of competition from weeds and stress from feeding by insects and slugs.

Title: Insects which Interfere with Establishment and Production of Sod-seeded Kale, Rape, Turnips, and Swedes

Leaders: R.A. Byers and G.A. Jung (U.S. Regional Pasture Research Laboratory)

Twenty-eight cultivars representing kale, rape, turnips, and swedes were evaluated in a sod-seeded nursery with six replications of each cultivar. Two species of flea beetles, Phyllotreta striolata and P. cruciferae, severely depleted seedling stands of these brassicas. Several cultivars showed resistance to flea beetle injury. Rangi and Wairoa rape had the highest plant density (65.8 and 64.2% ground cover) and the least flea beetle injury one month after planting. York turnip was the least injured turnip with 49.2% ground cover.



SECTION III

PLANT PATHOLOGY RESEARCH



Title: The Impact of Nematode Population Dynamics on Crop Growth and Yield, NE-133 (2495)

Leaders: J.R. Bloom, T. Kaufman, and G. Hunt (The Pennsylvania State University)

Alfalfa (Saranac-AR) and red clover (Tristan) seeds were planted in sand in thimble pots and inoculated with the clover cyst nematode, Heterodera trifolii, at the rate of 10, 5, or 1 nema/seed. Two weeks after planting, the seedling roots were stained with acid fuchsin and examined for the presence of nematodes. No nemas were found in roots at the one nema/seed level. At 10 and 5 nema/seed, the infection rate was 18 and 11%, respectively, for red clover, and 14 and 10% for alfalfa. Infected plants commonly contained more than one nema, with the nemas concentrated in one area. Tissue breakdown was evident in areas of feeding.

Red clover (Tristan) was planted in pint containers in soil treated as follows: 50 H. trifolii eggs/pot; 50 H. trifolii eggs + 100,000 spores of Myrothecium verrucaria/pot; M. verrucaria 100,000 spores/pot; uninoculated check. Stand in each pot was thinned to five plants. First and second cuttings showed no significant difference in fresh weight of treatments. Third cutting fresh weight was reduced by 50% in untreated check. In nematode-treated pots, plant stand was reduced to 0 to 3 plants/pot.

Title: Purple Leaf Spot of Orchardgrass

Leader: R.T. Sherwood (U.S. Regional Pasture Research Laboratory)

The accuracy of visual assessment of the severity of purple leaf spot, caused by Stagonospora arenaria, was studied. Two groups of five experienced scorers scored orchardgrass leaves for percent area infected by matching the leaves with published standard diagrams. Most scorers overestimated the true area of infection, and overestimation was greater at lower levels of infection. Most of the observers were unconsciously biased by the number of spots and, when considering two leaves with equal area infected, would assign higher scores to the leaf with more (but smaller) spots. Regression analysis indicated that overestimation was proportional to number of spots and inversely proportional to the log of the total infected area. Measurement techniques with greater reliability than visual assessment are needed for meaningful quantitation of disease increase, yield loss, and inheritance.

Title: Studies on the Biochemistry of Plant Disease Resistance

Leaders: D.L. Gustine and B.G. Moyer (U.S. Regional Pasture Research Laboratory)

White clover (*Trifolium repens* L.) callus tissue cultures accumulated the phytoalexin medicarpin after treatment with sulfhydryl reagents. After 24-hour exposures to sulfhydryl reagents, maximum obtainable levels of medicarpin, determined by high performance liquid chromatography analysis, were found with 50 mM N-ethyl maleimide, 25 mM HgCl_2 , 2 mM p-chloromercuribenzoic acid, and 0.5 mM iodoacetamide. Increased medicarpin levels were also observed in callus treated with p-chloromercuribenzenesulfonic acid, but the highest concentration tested (11.8 mM) did not produce the maximum response. After sulfhydryl treatment, medicarpin levels were unchanged for 4 to 6 hours but steadily increased thereafter, with maximum accumulation occurring by 48 to 50 hours for p-chloromercuribenzoic acid, p-chloromercuribenzenesulfonic acid, and HgCl_2 treated callus. Medicarpin levels did not increase in iodoacetamide-treated callus until 8 hours after sulfhydryl exposure, and medicarpin levels were still increasing linearly after 50 hours. Three other metabolic inhibitors, KCN, NaF, and Na_3AsO_4 , did not exhibit elicitor activity, indicating cell death was not a factor in the response. Pretreatment of callus with 20 mM dithiothreitol followed by 40 mM N-ethyl maleimide did not produce the phytoalexin response. Preincubation with dithiothreitol also prevented elicitor activity of HgCl_2 and p-chloromercuribenzenesulfonic acid. These results suggested that dithiothreitol pretreatment somehow prevented sulfhydryl groups within the cell from reacting with the test compounds. These experiments established that the integrity of sulfhydryl groups is important in regulating phytoalexin accumulation in callus cells.

Title: Bean Yellow Mosaic Virus Resistance in Red Clover

Leaders: S.H. Sim and K.T. Leath (The Pennsylvania State University and U.S. Regional Pasture Research Laboratory)

The feasibility of obtaining red clover plants resistant to bean yellow mosaic virus (BYMV) is being evaluated by collecting asymptomatic plants from old fields and by screening seedlings in the greenhouse. Symptom expression and indexing with ELISA are used to detect BYMV. BYMV was detected in about 50% of field-collected and inoculated seedlings. Plants that have remained uninfected thus far will be subjected to additional inoculations.

Title: Diseases of Birdsfoot Trefoil

Leader: K.E. Zeiders (U.S. Regional Pasture Research Laboratory)

The severity and importance of diseases of birdsfoot trefoil in research plots and pastures was monitored by periodic surveys from May 8 to November 5, 1981, at several locations in Pennsylvania. Diseases were also surveyed in field plots at Lexington, Ky., on June 19 and at a mine spoil reclamation site near Beckley, W.Va., on August 3. Stem canker and leaf spot caused by Stemphylium loti caused slight to moderate damage during the growing season in Centre and Jefferson Counties in Pennsylvania. Uncut plants in a variety nursery established in 1980 had moderate to severe damage by a combination of Rhizoctonia, stem canker, and potato leafhoppers in July. At Lexington, Ky., Rhizoctonia blight caused moderate to severe damage in a seed production field. At a mine spoil reclamation site near Beckley, W.Va., Rhizoctonia blight was present on about 40% of birdsfoot trefoil plants in a thick stand of grasses and birdsfoot trefoil. Of the perennial legumes at this site, birdsfoot trefoil had maintained a better stand after three years than other clovers and alfalfa.

In early August, severe root and crown rot developed in plantings of birdsfoot trefoil at Rock Springs, Pa., resulting in death of about 40-50% of the plants in one field. Roots of dead plants were badly rotted and decayed. The causal agents were identified as Mycoleptodiscus and Fusarium. Several species of nematodes, including Paratylenchus, Xiphinema, and Aphelenchus were also involved. These plants were cut on June 1 and July 14 prior to the outbreak of root rot. Stress caused by a low height of clipping may have been a factor in the disease syndrome. This was the most serious loss observed in 1981.

Rooted cuttings of 69 birdsfoot trefoil plants selected for resistance to Fusarium wilt from among 11 varieties in a greenhouse screening test were sent to plant breeders at Columbia, Mo., and Ithaca, N.Y., for use in their breeding programs. At University Park, Pa., on June 8, four replications of the 69 selections were set in an isolated field as space plants in a randomized complete block design for disease evaluation and seed production. Polycross seed was harvested from nearly all plants in mid-August. Plants were not cut during the growing season and no plants died. On October 14 most plants had few disease symptoms. The disease observed most frequently was Stemphylium stem canker. Most plants made a decumbent type of growth, except clones derived from Viking which were more upright.

A total of 36 birdsfoot trefoil varieties, breeding lines, and plant introductions obtained from Guelph, Ont., Columbia, Mo., and Geneva, N.Y., were screened for resistance or tolerance to Fusarium wilt in the greenhouse. Up to 40 plants of each entry were inoculated on July 6, 1981, with virulent cultures of F. oxysporum from the Westport, N.Y., area. Plants were started from seed on March 27, 1981. Data on the number of plants healthy, wilted, and dead were recorded on August 12, October 15, November 17, and December 21. By December 21 only 180 out of 1,234 plants (14.6%) inoculated were free of wilt. These plants will be retained for use in breeding programs in the Northeast. Numbers of wilt-free plants among entries ranged from 13 for LA Syn from Guelph, Ont., to none for PI 250571 from Geneva, N.Y. The 10 best entries in order were: LA Syn, Viking, PI 255 177, FS Syn, PI 262 531, PI 290 717, FC 39604 (HCN), FRG Syn, EA Syn, and ER Syn. This list includes five of the six entries from Guelph. These plants were also among the most vigorous in the test.

Title: Netblotch of Tall Fescue

Leaders: N.R. O'Neill and J.J. Murray (Beltsville Agricultural Research Center)

The influence of spore age and incubation temperature on prepenetration events and colonization of tall fescue leaves by Drechslera dictyoides was determined. Tall fescue plants 8 weeks old were inoculated at temperatures of 10 to 30 C with suspensions of conidia taken from cultures incubated for 9, 16, 30, and 46 days. Leaves were examined at 12, 24, and 48 hours for prepenetration events and leaf colonization. Spore germination, germtube elongation, and appressorium formation were complete within 24 hours and were inhibited as spore age increased. Formation of subepidermal vesicles, primary and secondary hyphae, and cellular necrosis occurred within 48 hours and was greatest from 16-day-old cultures. Only direct penetration was observed. The optimum spore age and incubation temperature for rapid and severe infection by artificial inoculation was 16 days and 20 to 25 C. In in vitro studies, germination and germtube lengths of spores were greatest from cultures 7 to 16 days old and were inhibited as spore age increased and as incubation temperatures decreased from 30 to 10 C.

Title: Diseases of Warm-Season Forage Grasses

Leader: K.E. Zeiders (U.S. Regional Pasture Research Laboratory)

New pathogenic fungi were isolated from leaf spots on Plains old world bluestem and indiangrass at Milesburg, Pa. Both fungi are as yet unidentified. In greenhouse inoculation tests, the fungus from Plains bluestem had a wide host range, causing moderate to severe leaf spot disease on Plains bluestem, caucasian bluestem, big bluestem, indiangrass, sudangrass, and smooth brome grass; disease was slight to moderate on corn, orchardgrass, and little bluestem. Switchgrass, little bluestem, six cool-season grasses, and three small grains were resistant or immune. This fungus was also isolated from leaf spots on Plains bluestem at Wardensville, W.Va. The fungus from indiangrass (isolate #1442) caused severe leaf spot disease on indiangrass but did not attack seven other warm-season grasses, six cool-season grasses, or three small grains. Corn was mildly attacked. This fungus caused moderate to severe leaf spot on indiangrass at Milesburg but was not isolated from indiangrass from any other location.

A species of Helminthosporium of the H. sativum group from Pennisetum flaccidum at Milesburg caused moderate to severe leaf spot on P. flaccidum, indiangrass, switchgrass, reed canarygrass, tall fescue, corn, and wheat in greenhouse inoculations. Big bluestem, little bluestem, and several cool-season grasses were less susceptible. Caucasian bluestem and Plains old world bluestem were resistant. The Helminthosporium from Pennisetum and the unidentified fungus from Plains bluestem each had rather broad host ranges among forage grasses, while the fungus from indiangrass was confined almost entirely to indiangrass.

In 1981, the severity of leaf spot disease on warm-season grasses was surveyed and rated in plots in Huntingdon County and at Milesburg and Rock Springs in Centre County in July, August, and October. On July 20, disease severity on warm-season grasses at Wardensville, W.Va., was surveyed and rated. The ratings showed what has been observed for several years--that disease severity on the same species often varies considerably between locations. For example, the wide differences between the Milesburg and Huntingdon County locations observed this year were nearly the same as reported in 1979 and 1980. Ky-1625 switchgrass had less severe leaf spot disease than five other switchgrass varieties at Milesburg, and much less than Pathfinder and NJ-50 in field-scale plots at the Rock Springs Agricultural Research Center in August and October.

Title: Virulence of Fusarium roseum Acuminatum and Avenaceum in Red Clover

Leaders: J.C. Stutz and K.T. Leath (The Pennsylvania State University and U.S. Regional Pasture Research Laboratory)

Virulence of Fusarium roseum Avenaceum and F. roseum Acuminatum in red clover roots was evaluated from the standpoint of potential toxin involvement and the effect of wounding. In seedlings and in root tip inoculations, both Fusarium cultivars penetrated, formed distributive hyphae, and colonized roots in a similar manner, with necrosis apparent after 6 days. In 5-week-old plants, F. roseum Avenaceum was more virulent than F. roseum Acuminatum as measured by frequency and severity of necrosis. There were distinct differences in fungal development between the cultivars in roots inoculated at least 2 cm from the root tip. F. roseum Acuminatum penetrated the epidermis in this area, but further cortex colonization was limited to swollen hyphae, resembling chlamydospores. Neither distributive hyphae nor necrosis was observed. F. roseum Avenaceum colonized the cortex via distributive hyphae and caused necrosis in this area.

Wounding of roots at the inoculation site increased the frequency and severity of necrosis caused by isolates of each F. roseum cultivar. All isolates penetrated epidermal cells in close proximity to the wound opening; only rarely were hyphae seen directly entering through the wound. Wounding accelerated penetration and colonization by all isolates. The development of F. roseum Avenaceum was the same in wounded and nonwounded roots, but the development of F. roseum Acuminatum was not. When roots inoculated 4 cm from the root tip were wounded, isolates of F. roseum Acuminatum behaved like F. roseum Avenaceum in that they formed distributive hyphae and caused necrosis. The swollen hyphae stage did not occur.

Toxin production by both Fusarium cultivars was assayed using seed germination, rust spore germination, and root electrolyte and potassium ion leakage to detect biological activity. Although activity was detected, it did not correlate with virulence of the isolates. Histological examinations of infected roots showed a close relationship between distributive hyphae development and visible symptoms. Neither assay results nor histological observations suggest a major role for toxins in either pathogenicity of these F. roseum cultivars in red clover or as an explanation of virulence differences between isolates.

Title: Nature of Resistance of Grasses to Fungal Disease

Leader: R.T. Sherwood (U.S. Regional Pasture Research Laboratory)

Further evidence was found to indicate that susceptibility of grass and cereal leaves to necrotrophic leaf spot fungi is focused at the stomatal region. Cross inoculations of reed canarygrass and orchardgrass with Stagonospora species from each showed a high rate of success of penetration attempts near stomates. The same pattern was found for wheat inoculated with Helminthosporium sativum at widely different temperatures.

The nature of adult plant resistance (APR) of oats to powdery mildew at the penetration stage was studied. Spore germination and site of penetration were not related to APR but papilla formation was. APR of Dal differed from that of Maldwyn. APR was temporarily suspended by heat shock treatment (50 C, 90 sec) but was restored within 24 hours. Levels of peroxidase, an enzyme implicated in lignification of papillae, were correlated with expression of APR.



SECTION IV

GROWTH, PHYSIOLOGY, AND
CLIMATIC EFFECTS



Title: Effects of Zn Supply on P Accumulation in Different Plant Species Grown in Nutrient Solutions

Leaders: R.M. Welch and J.F. Loneragan (U.S. Plant, Soil, and Nutrition Laboratory and Murdoch University, Murdoch, Western Australia)

The relationship between P toxicity and Zn supply was studied in five plant species (barley (Hordeum vulgare), sweet corn (Zea maize cv. IOCHIF), wheat (Triticum aestivum cv. Gamenya), subterranean clover (Trifolium subterraneum cv. Seaton Park), and tomato (Lycopersicon esculentum cv. Grosse Lisse)). Plants were grown in the greenhouse in nutrient solutions containing 2 mM P and either without Zn (Zn_0) or with 2.5 μ M Zn (Zn_1). Harvested plant material was separated into roots, selected leaves, and rest of tops.

At Zn_0 , plant yields were generally reduced with the younger leaves being the most affected. Characteristic Zn deficiency symptoms of "little leaf" and "rosetting" developed in the young leaves of tomato and clover plants. Chlorotic and necrotic areas also developed in the interveinal areas of older leaves in all species except tomato. At Zn_1 , none of these symptoms was apparent.

At Zn_0 , proportionately more total P and Zn accumulated in older leaves than in other plant parts when compared to Zn_1 plants. Except for tomato, plant symptoms in older leaves correlated with toxic P concentrations of from 1.28 to 3.35% dry weight in those leaves. Supplemental Zn dramatically reduced total P content and concentrations in older leaves of all plant species. P toxicity was responsible for the necrotic symptoms in older leaves.

These results confirm our earlier findings with okra and suggest that Zn may perform some function in plants pertaining to P metabolism because Zn deficiency enhances P accumulation by plants and interferes with P mobilization in tops.

Title: Selection Studies for Increasing Alfalfa Forage Yields

Leaders: F.W. Snyder and J.H. Elgin, Jr. (Beltsville Agricultural Research Center)

Growth rate, mean growing capital, some morphological characteristics, and stand persistence are known to influence biomass yield of alfalfa. We are using spaced plants in the field to identify those with high biomass production, to determine components that influence biomass, and to measure their degree of heritability.

Experiment 1

About 1,000 7-week-old seedlings of the experimental germplasm BMP 8 (Arc x Saranac-AR) were transplanted to a space-planted field nursery in early May 1980. As each plant showed bud color, it was cut and the forage dried and weighed. Individual plants bloomed from 0 to 7 times by mid-September. Four groups of about 50 plants each were identified and cloned.

<u>Group</u>	<u>Field Characteristics</u>
1	High growth, ≥ 0.45 grams dry weight per day, 0-2 cycles of flowering
2	High growth, ≥ 0.45 grams dry weight per day, 3-4 cycles of flowering
3	Low growth, ≤ 0.16 grams dry weight per day, 0-3 cycles of flowering
4	Low growth, ≤ 0.16 grams dry weight per day, 4-7 cycles of flowering

Each group was isolated in the greenhouse under cages with bees for seed production. After seed production, individual seedlings of each group were grown in controlled environment chambers in vermiculite in 10 cm square, 20 cm tall pots. A complete mineral nutrient solution was added daily. Plants were harvested for shoot fresh weight about 33 days post-emergence. Each mean value in the table below is for 23 to 25 plants.

<u>Group</u>	<u>Chamber 1</u>		<u>Chamber 2</u>	
	<u>Fresh weight of shoot (g)</u>		<u>Fresh weight of shoot (g)</u>	
	<u>Mean</u>	<u>Range</u>	<u>Mean</u>	<u>Range</u>
1	9.93	4.11 - 15.82	13.81	4.14 - 22.76
2	10.46	4.67 - 15.91	14.89	7.08 - 24.18
3	9.39	3.76 - 15.95	11.28	2.34 - 20.89
4	10.58	4.76 - 14.87	13.50	5.43 - 20.17

Despite the approximately three-fold difference in yield of the parents, the progenies differed by only about 10%. The range within each group appeared to be similar. The field growth of the parent plants measured in 1980 was again measured in 1981. The first cutting of groups 1 and 2 averaged more than two-fold greater forage yield than groups 3 and 4. The number of cycles of flowering were also determined for each plant throughout the season. Plants of groups 1 and 3, with the lesser number of flowering cycles in 1980, averaged about one less cycle than the plants in groups 2 and 4. Thus, there was some consistency in number of flowering cycles of the clones in the two years of study.

Experiment 2

The plants with early and frequent flowering in Experiment 1 had reduced yield because they were cut at time of bud color and not allowed to complete more of their growth cycle. Would this lower yield also occur with the normal 3 or 4 cuttings in commercial alfalfa?

This experiment involves about 1,000 spaced transplants of BMP 8. Dates of first bud color were recorded for all plants as flowering occurred throughout the growing season. During the first growth cycle, 60% of the plants in the even numbered rows were rogued when flowers first appeared, leaving the 40% of the plants with delayed flowering. All of the plants in the odd numbered rows were retained and served as the control population. All plants were harvested on June 19, again on July 13, and again on August 11. Between September 14 and 22, all plants were harvested a fourth time and the fresh weight of forage was recorded for each plant. We identified 122 of the highest yielding plants. Clones have been made for greenhouse seed production. Progenies of these selections will be tested against unselected progenies. Forage of each of the 122 identified parent plants will be weighed the first cutting in the spring of 1982.

Title: Studies of Allelochemical Properties of Forages and Their Effect on Forage Quality

Leader: D.L. Gustine (U.S. Regional Pasture Research Laboratory)

Some 10 years ago investigators first observed that crownvetch (Coronilla varia L.) was toxic when fed to nonruminant animals (meadow voles, chickens, and swine). Subsequently, it was shown that 3-nitropropionic acid (NPA) was both the toxic constituent in the forage and an irreversible inhibitor of succinate dehydrogenase (SDH). This led to the hypothesis that NPA is toxic because inactivation of SDH in vitro severely limits biochemical respiration. To examine this hypothesis, Swiss-Webster mice (36) were injected intraperitoneally with NPA (120 mg/kg) at 0 and 24 hr. At 30 hr, heart, liver, or brain tissue was homogenized in buffered 0.32M sucrose and mitochondria isolated by repeated centrifugation through fresh buffered sucrose solutions. Mitochondria isolated in this manner contain all of the cellular SDH enzyme molecules. Further, only SDH molecules that have not been inactivated by NPA will retain enzymatic activity. Mitochondrial SDH and α -glycerophosphate dehydrogenase activities were determined by the method of Singer (Meth. Biochem. Anal. 22:123 (1974)). SDH specific activities in heart, liver, and brain mitochondria were 13.8, 25.9, and 20.3%, respectively, of the specific

activities determined in saline injected control mice. The reduction in mitochondrial SDH specific activity from each tissue was significant ($P=0.01$) and the level for each tissue was significantly different from the others ($P=0.01$). Specific activities of mitochondrial α -glycerophosphate dehydrogenase were unaffected in liver and brain of 3-nitropropionate-treated animals (not assayed in heart), indicating NPA did not inhibit mitochondrial enzymes in a nonspecific manner. These results strongly suggest that the principle mode of 3-nitropropionate toxicity in nonruminants is caused by debilitating restriction of normal respiration as a result of irreversible inactivation of SDH in vivo.

Previous investigations showed that NPA does not affect ruminant animals because it is metabolized to nontoxic products in the rumen before it can be absorbed into the circulation (J. Anim. Sci. 44:1107-1111 (1977)).

Title: Perennial Ryegrass and Hybrid Derivatives as Northern Forage Crops

Leader: G.M. Wood (University of Vermont)

Diplomat perennial ryegrass persisted through three winters in a nitrogen fertilization study (0, 50, 100, 150, 200 kg/ha/year) without injury. In the third year, the 0 nitrogen rate plots were invaded with dandelion and red clover, whereas all other plots maintained essentially pure stands. Dry matter yields were comparable to what might be expected from timothy.

Title: Effects of Genotypes and Environments on Growth of Forage Legumes

Leader: W.A. Kendall (U.S. Regional Pasture Research Laboratory)

A slant-board culture technique that was developed at this laboratory to facilitate studies of roots (Crop Sci. 14:317 (1974)) was modified to maintain an aseptic plant environment. Each slant-board is enclosed in an isolator that permits access to the roots for inoculation of pathogens. An aseptic transfer-hood is used to assemble the units. Plant growth chambers are used to provide light and temperature control. The new method facilitates the study of interactions of fungi, bacteria, and insects as they affect root rots of legumes with plants up to 5 weeks old.

Title: Tissue Culture and Regeneration of Crownvetch

Leaders: B.G. Moyer and D.L. Gustine (U.S. Regional Pasture Research Laboratory)

Hypocotyls excised from sterile seedlings of Coronilla varia cv. Penngift, Chemung, and Emerald were used to initiate callus cultures. Gamborg's B5 medium with 1.25 mg 2,4-D, 0.25 mg NAA, and 0.25 mg kinetin/l was used for both initiation and maintenance of cultures. Only one-third of the cultures established showed potential for embryogenesis. Although both embryogenesis and subsequent development is inhibited by 2,4-D in lines with the highest potential, embryogenesis occurred on the maintenance medium; embryos dedifferentiated unless transferred to B5 with hormones omitted (basal B5). Other lines required transfer to basal B5 for initiation of embryogenesis; lines with the weakest potential required transfer to a third medium, basal Blaydes with 100 mg inositol and 2 g yeast extract/l. Embryos formed varied in size; the largest readily formed roots and true leaves on basal B5 or half-strength Hoagland's + 10 g sucrose/l. Plants thus formed were successfully transferred to soil.

Title: Physiology and Persistence of Alfalfa in Relation to Liming

Leaders: G.O. Estes and Desta Beyene (University of New Hampshire)

Field and greenhouse studies evaluated limestone treatments on production, persistence, and nutrition of Iroquois alfalfa. In the field, alfalfa was grown at four rates of incorporated dolomitic limestone (0, 3.5, 6.9, and 13.8 t/ha) with yields and soil and tissue analyses taken over a 6-year period; greenhouse evaluation was made of ^{32}P mobility in alfalfa tissue in relation to lime treatments.

Six years after the August 1975 establishment, protein yields showed significant improvement from liming, with first harvest values in 1981 of 862 and 1,541 kg/ha for the control and 3.5 t/ha limestone treatments, respectively. Optimum economic benefit from limestone was obtained with 3.5 t/ha which yielded 14.9 t/ha of dry matter in 1981 with an associated herbage composition in the first harvest of 4.2% N, 0.33% P, 2.4% K, 1.0% Ca, and 0.32% Mg. Soil pH increases in the field were correlated with decreased levels of exchangeable Al (1N KCl) and available P (Bray 1); the greatest reduction in Al occurred with 3.5 t/ha of limestone. There was an increase in the number of crowns/m² with liming, from 35 to 50 for the 0 and 13.8 t/ha treatments, respectively.

Greenhouse results with ³²P showed that P absorption and mobilization were severely reduced at high lime rates in several varieties of alfalfa.

Title: Lime Responses of Kentucky Bluegrass, Tall Fescue, and Fineleaf Fescue Cultivars on an Acid, Aluminum-toxic Soil

Leaders: J.J. Murray, L.C. Taylor, and G. Jones (Beltsville Agricultural Research Center and Virginia Polytechnic Institute and State University)

To evaluate laboratory screening methods for acid soil tolerance, field plots were established in 1977 consisting of cultivars sensitive and tolerant (based on laboratory tests) to acid soil conditions. Twenty Kentucky bluegrasses and 10 fescues were established on Tatum soil limed to four pH levels.

Fourth-year data were consistent with that of previous years. Based on drought tolerance and stand density (plants/unit area), tolerance of fescues in the field was positively correlated with laboratory testing. Disease response of Kentucky bluegrass cultivars in the field made it impossible to obtain meaningful correlations with laboratory testing for acid soil tolerance.

Title: Switchgrass Establishment

Leaders: M. Panciera, G.A. Jung, and W.C. Sharp
(The Pennsylvania State University, U.S. Regional Pasture Research Laboratory, and Soil Conservation Service)

Cooperative studies with Soil Conservation Service scientists were continued to investigate seedling development and physiology of switchgrass cultivars developed in different regions of the United States. Dry matter partitioning in 1981 was again different for Blackwell and Ky 1625 switchgrasses. Ky 1625 put proportionately less photosynthate into stem tissues and more into crown and root tissue than did Blackwell. Blackwell was successfully established from plantings in early May until early June, whereas Ky 1625 established well only when planted in early May. Germination studies with seed of switchgrass cultivars of diverse origin revealed differences in germination that were due to cultivar, location of seed production, and temperature regimes. Some cultivars have a seed dormancy factor; temperature requirements for germination differ for switchgrass cultivars.



SECTION V

WEED INVESTIGATIONS



Title: Winter and Summer Annual Weed Control in Alfalfa

Leaders: R.L. Ritter and T.C. Harris (University of Maryland)

Many herbicides are labeled for the control of winter annual weeds in established alfalfa. Relatively few herbicides are available for controlling summer annuals in established swards. Thus it is hard to maintain alfalfa stands in a weed-free state all year round. This experiment, conducted in 1981 at the Forage Research Farm in Ellicott City, Md., was designed to examine herbicide control programs for winter and summer annual weeds in established alfalfa.

Alfalfa (var. Saranac-AR) was planted in the spring of 1979 in a site known to have a variety of winter and summer annual weeds. The soil was a Chester silt loam. In the fall of 1980, plots were established to examine a variety of herbicide treatments to be applied during the winter and summer of 1981. Dormant treatments were applied on March 12, first cutting treatments on June 1, second cutting treatments on July 2, and third cutting treatments on August 19. Plot size was 15 x 25 ft and arranged as a randomized complete block design with three replications. Herbicides were applied with a CO₂ pressurized backpack sprayer that delivered 20 gpa at 20" psi using SS-8003 flat fan nozzles. Visual ratings were made, based on a scale of 0 to 100, with 0 = no control and 100 = total control. Yields were taken and hand separations made of the weeds and alfalfa.

Multiple applications of paraquat (1/2 lb ai/A applied dormant, and 1/8 to 1/4 lb ai/A applied after second and third cuttings) provided excellent weed control and provided good crop tolerance.

Multiple applications of hexazinone (0.6 lb ai/A applied dormant, and 0.6 lb ai/A applied after first cutting) provided good winter annual weed control and good early summer weed control. By late season, many summer annuals broke through this treatment.

One of the best treatments was a multiple application of terbacil (0.6 lb ai/A applied dormant, and 0.6 lb ai/A applied after first cutting). By late August, weed control averaged 95% across all replications. Good alfalfa yields were also maintained with this treatment.

A variety of new post-emergence grass control materials were examined for use between cuttings. Due to the variety of summer annual broadleaf weeds, these materials would not be effective unless tank-mixed with a broadleaf control material.

Title: Integrated Pest Management in No-tillage Systems for Forages and Rotations Involving Forages

Leaders: D.L. Linscott and R.F. Lucey (USDA-ARS and Cornell University)

In 1981, the herbicide control programs were such that nonsignificant differences were obtained in weed control in conventional no-tillage or mixed systems for corn with the concomitant stand and yields being nonsignificant. Corn yields averaged 145 bu/A from end populations of 24,500. In the case of oats, tillage x herbicide interactions were significant. The no-till oats responded to herbicide treatment, whereas conventionally planted oats did not. Conventional oats yielded 88 bu/A, whereas no-till oats yielded 42 bu/A with herbicide and 26 bu/A without. For alfalfa, newly established plant numbers were higher in no-till compared with conventional systems. Herbicide use increased the alfalfa stand and significantly decreased the weed population.

In 1981, insecticide (carbofuran) or fungicide (bayleton) produced no significant difference in corn stand or yield. No interaction of tillage x pesticides was detected. Alfalfa responded significantly to carbofuran treatments but not to a fungicide. No pesticide-tillage interactions were found. Oats responded to early fungicide treatments. The tillage x fungicide interaction was not significant. Mesurol, Furadan, and Dyphonate alone, and Mesurol + Furadan and Mesurol + Dyfonate in combination, were evaluated for pest control during direct-seeded alfalfa establishment in oat stubble. In general, Furadan alone or Furadan + Mesurol were the superior treatments based on means of three planting dates. Beneficial effects of Mesurol were not detected in 1981 in contrast with previous years. Few slugs were noted in the spring of 1981. Dyphonate was ineffective in 1981.

Title: Integrated Weed Control and Limited-tillage Systems for Forages, Pastures, and Rotations

Leaders: D.L. Linscott and R.D. Hagin (USDA-ARS and Cornell University)

Twelve compounds have been isolated from quackgrass rhizomes which inhibit alfalfa root growth. Some are severe germination inhibitors. One isolated phenolic glycoside has little effect on alfalfa germination but is a very active inhibitor of root growth at levels of 10 to 100 ppm under normal atmospheric conditions. Under partially O₂ restricted conditions, it severely inhibits both germination and root growth at levels of 1 ppm or higher.

In studies on the productive process in yellow nutsedge, we determined (1) that the time from emergence to tuber initiation varies as the growing season progresses and is not fixed as has been previously reported, (2) that all interactions at time of emergence, stage of growth at treatment, and type and rate of herbicide are significant in terms of reproductive tuber production and viability.

Two new post-emergence grass killing herbicides, sethoxydim and fusilade, and the standard dalapon were evaluated for control of annual grasses in direct-planted alfalfa. Both sethoxydim (0.4 lb/A) and fusilade (0.5 lb/A) controlled smooth crabgrass, barnyard grass, and yellow foxtail in the new seedings, and both were superior to dalapon in effect. When the grass herbicides were applied in combination with 2,4-DB (1-1/2 lb/A), excellent grass and broadleaf control and subsequent alfalfa establishment were obtained. Both sethoxydim and fusilade have excellent potential for commercial development.

HOE 00661 was compared with glyphosate and paraquat for control of brome grass sod during direct planting of alfalfa in the sod. HOE 00661 was intermediate between paraquat and glyphosate in speed of action on brome grass. This new herbicide has potential for sod-grass control.

Title: Fall and Spring Herbicide Treatment of Sods for Minimum-tillage Seeding of Alfalfa

Leaders: D.W. Koch and G.W. Mueller-Warrant (University of New Hampshire)

Fall and spring herbicide applications were compared for effectiveness in vegetation control at four locations. One sward was dominated by quackgrass, two swards contained a diversity of perennial grasses and broadleaf weeds, and a fourth was dominated by a mixture of cool-season grasses. Spring applications of glyphosate were more effective than fall applications in controlling vegetation on all but the quackgrass sward. On the quackgrass sward, fall and spring glyphosate treatments were equally effective in reducing competition from quackgrass and in alfalfa establishment. Pronamide applied at 3.4 kg/ha controlled perennial grasses but not broadleaf weeds. When pronamide was applied at 2.2 kg/ha in the fall and followed by paraquat at 0.3 kg/ha at the time of seeding, both grass and broadleaf weeds were controlled. Alfalfa established more slowly in the paraquat-treated and check plots than with glyphosate. There was a rather surprising increase from the seeding year to the following spring harvest in alfalfa yields from plots receiving paraquat and from those receiving no herbicide.

Title: Multiflora Rose Control: Effect of Cutting

Leader: W.B. Bryan (West Virginia University)

The objective of this experiment is to examine the response of individual multiflora rose plants to different cutting intervals. In May 1980 discrete multiflora rose bushes were cut close to ground level. Regrowth was cut or stripped from the stumps at 1-, 2-, 4-, and 8-week intervals. Number and length of shoots, and hardness of thorns was noted before each cutting. The experiment continued through 1981. Plants cut every week remained below 8 inches in height, and thorns were poorly developed. Plants cut every 2 weeks reached about 15 inches in height and differed little from those cut at 4-week intervals. Plants cut every 8 weeks produced the tallest regrowth (over 50 inches); however, they produced fewer shoots than most of the other treatments. Stripped plants produced less shoots than cut plants. One and two monthly clippings showed strong development of thorns except at the end of the growing season.

By April 1981 (11 months after the experiment began), only four plants had died. By July 1981, however, 12 plants had died, and by the end of 1981, only three plants were alive. There appeared to be little relationship between frequency of cutting and how soon plants were killed. This experiment indicates that persistent cutting or grazing of regrowth will kill multiflora rose. Red clover seed was oversown around two of the multiflora rose plants clipped every 2 weeks. Cattle were grazing in the area and regularly grazed the rose regrowth along with the red clover.

Title: Glyphosate Timing, Seeding Date, and Residue Effects on Sod Seedings of Alfalfa

Leader: D.W. Koch (University of New Hampshire)

Glyphosate was applied to orchardgrass, timothy, and brome grass sods 3 days prior to May 13, May 20, and May 27 seedings of alfalfa. Glyphosate was also applied 10 and 17 days prior to the latter seeding. Residue (treated topgrowth) was removed immediately prior to seeding and was either left off, replaced, or replaced in addition to that from plots left bare. An increase in residue level with progressively later glyphosate treatment tended to result in reduced alfalfa seedling density, lower alfalfa yields, and less annual weed competition. For a given seeding date, earlier glyphosate application: (1) did not influence alfalfa seedling density, (2) significantly increased alfalfa yields, and (3) conserved greater amounts of soil moisture. May 13 seeding resulted in lowest alfalfa yields.

Title: Control of Winter Annual Weeds in Established Alfalfa Stands

Leaders: A.M. Decker, L.R. Vough, T.H. Miller, and J.H. McNemar (University of Maryland)

Furloe (2 qt early winter), Sencor (1 and 2 pt early and late winter), and paraquat (0.5, 1, 2, 3 pt early and late winter) were applied to an established stand of alfalfa. Chickweed and other winter annual weed pressures appeared to be similar to those present the previous year. Unusually warm weather in late February and March resulted in rapid early growth of alfalfa, and weed competition was almost absent during the first harvest. About the only thing that can be reported is that herbicides applied to the essentially weed-free stands did not affect alfalfa yields during the first harvest.

Title: Use of Herbicides in Forage Crop Management

Leaders: R.A. Peters, F.W. Himmelstein, and J. Zaprzalka (University of Connecticut)

Development of no-tillage forage systems for Connecticut was continued. Emphasis was placed on evaluation of herbicides which will control crabgrass in no-tillage alfalfa seedings. Presently available herbicides must be preplant incorporated. Therefore, they cannot be used for no-tillage seedings. The chemicals used in 1981 were BAS 9052 OH, CGA 82725, Ro 13-8895 (acetone O-[D-2-[p-[a,a,a, trifluoro-p-tolyl oxy] phenoxy] propionyl] oxime) and diclofop (2-[(2,4 dichloro-phenoxy) phenoxy propanoate). The first three materials were applied both pre- and post-emergence. The post-emergence treatments were applied when the crabgrass was 5 to 7.5 cm in height in the fourth leaf stage and just starting to tiller and at the 15 to 20 cm height. Diclofop was applied at planting and 10, 17, and 20 days after planting. Diclofop controlled crabgrass if applied within 2 weeks of planting. Ro 13-8895 and CGA 82725 controlled crabgrass at all times of application. BAS 9052 was considerably less active on crabgrass when applied pre-emergence but did give good post-emergence control. Alfalfa yields were significantly increased as a result of the crabgrass control. Early post-emergence treatments had an advantage in alfalfa yields over late post-emergence applications since crabgrass was competitive for a shorter time span. The herbicides discussed above offer promise for annual grass control in no-tillage legume seedings where preplant incorporation is not possible.

A comparison was made between paraquat and glyphosate applied between alfalfa cuttings for control of crabgrass (*Digitaria sanguinalis*). Applications of paraquat 0.28 kg/ha applied after the second cut of alfalfa gave complete control of crabgrass without alfalfa injury. Glyphosate at 0.56 kg/ha applied at the same time also controlled the crabgrass but caused unacceptable injury to the alfalfa. On established dormant alfalfa, applications of 0.14, 0.28, and 0.56 kg/ha paraquat and 0.28 and 0.56 kg/ha glyphosate were applied on April 8, 1981, when the new alfalfa growth did not exceed 2 inches. Excellent control of overwintering daisy fleabane (*Erigeron canadensis*) was obtained from the glyphosate but not with paraquat. No alfalfa injury occurred. The information which has been obtained indicates that glyphosate has a distinct advantage over paraquat for the control of weeds but is less selective on alfalfa.

Title: Paraquat for Control of Summer Annual Grasses in Established Alfalfa

Leaders: L.R. Vough, A.M. Decker, J.H. McNemar, and T.H. Miller (University of Maryland)

Studies involving the use of paraquat, sprayed on alfalfa stubble immediately after the crop is removed, for the control of weedy annual grasses and other weeds was continued for the third year.

Paraquat was applied at three rates after the second alfalfa harvest. Third-harvest yields were as follows:

<u>Treatment</u>	<u>Metric Tons per Hectare</u>		
	<u>Alfalfa</u>	<u>Weeds</u>	<u>Total</u>
Check	0.76	1.93	2.69
Paraquat (0.50 pt)	1.17	0.98	2.15
Paraquat (0.75 pt)	1.32	0.54	1.86
Paraquat (1.00 pt)	1.46	0.36	1.82

Paraquat applications were likewise made after the third harvest; however, there was no weed pressure in the fourth crop, so treatments were not harvested.

Title: Control of Annual Grasses in Alfalfa

Leaders: J.A. Meade, R.L. Washer, and David Lee (Rutgers University, Burlington County Agricultural Extension, and Salem County Agricultural Extension)

Control of fall panicum and crabgrass was achieved by the application after second cutting of the experimental compounds sethoxydim, fluazifop, and CGA 82725. Paraquat effectively controlled fall panicum but was weak on crabgrass. Asulam was very effective on crabgrass but weak on fall panicum. Terbacil and hexazinone applied at this time controlled both species of grass. None of the treatments injured the alfalfa.

SECTION VI

MANAGEMENT AND PRODUCTION RESEARCH

Title: Forage-Livestock Systems for Land with Soil and Site Limitations--Establishment Phase, Grasses

Leader: W.B. Bryan (West Virginia University)

Two experiments were initiated in 1981. In the first experiment, early, medium, and late planting dates were compared with and without Furadan. Blackwell switchgrass and Kentucky 31 tall fescue were sod seeded into a native pasture with a Tye seeder. In the second experiment, only Blackwell was sod seeded at the medium date and the effects on establishment of Furadan, glyphosphate banded or broadcast, and atrazine compared. Furadan increased the number of switchgrass seedlings, especially at the early (May 1) and late (June 8) seeding dates. Furadan increased the number of tall fescue plants at all planting dates. The amount of bare ground increased with later dates of planting. Furadan was more effective in increasing stand of switchgrass than atrazine, and both increased stand compared to the control.

It is planned to harvest these plots during 1982 and determine forage yield and botanical composition.

Title: Fertilization of Corn in Monoculture for Silage Production

Leader: W.W. Washko (University of Connecticut)

A study of corn grown in long-term monoculture for silage production was conducted over a 9-year period to compare effects of modifying manure and fertilizer treatment. Plots were established on dairy farms in the major dairy regions of Connecticut on fields either heavily manured annually or not manured. The most common soil types utilized for corn in the state were represented.

Optimal and comparable yields on prior heavily manured fields were obtained either with cow manure or with complete fertilizers applied according to current soil test recommendations. Thirty tons per acre annually of cow manure appeared to be the amount adequate to produce corn silage at the highest yield levels obtainable. Corn silage production declined at the approximate rate of 10% per year as manure application was discontinued and no fertilizer was applied.

At non-manured sites, current applications of fertilizer were required to sustain high yield levels. Yields without current fertilizer additions were 50 to 60% of those obtained with fertilizers applied according to soil test.

Title: Influence of Macro- and Micro-Element Fertilization on Yield and Longevity of Alfalfa

Leaders: R.R. Weil, L.R. Vough, A.M. Decker, T.H. Miller, and J.H. McNemar (University of Maryland)

Maximum dry matter yields in alfalfa variety trials and management studies in central Maryland are 14.5 to 15.0 mt/ha. Given the length of the growing season in this area, higher yields should be possible. Results of previous studies indicate that P and K are probably not the limiting factors, but other elements might possibly be limiting.

An alfalfa fertility experiment to investigate the influence of fertilization on yield and longevity was initiated in the fall of 1981 when a no-till seeding was established. Fertility variables are P, K, S, and Mg, with some treatments including 20 dry mt/ha of dairy manure plowed down the previous spring. Annual application rates are 0, 75, 150, and 225 kg P/ha; 0, 200, 400, and 600 kg K/ha; 0, 25, 50, and 75 kg S/ha; and 0, 50, and 150 kg Mg/ha.

Title: Renovation of Old Alfalfa Stands without Tillage

Leaders: G.W. Mueller-Warrant and D.W. Koch (University of New Hampshire)

No-tillage seedings of alfalfa were made on six old, poor stands of alfalfa. On all fields, fertility had been maintained in the medium-high range according to soil test interpretation, and all had a pH of 6.0 or higher. Fall application of glyphosate or pronamide removed perennial grasses from the swards, increasing yield of old alfalfa but decreasing total forage yield compared to untreated checks. Establishment of new alfalfa seedlings was seriously hindered by the presence of 10 or more old alfalfa plants per M². Establishment of a sufficient number of alfalfa seedlings to improve the stand over that initially present required suppression of the old alfalfa with paraquat or glyphosate in addition to elimination of the grasses. Spring seedings made within several days after use of glyphosate to kill the sward had reduced seedling densities and first harvest alfalfa yields compared to those made several weeks after glyphosate application. This effect was most pronounced on the least well-drained soils. Best stands of alfalfa following renovation were obtained through use of fall-spring split application of glyphosate or pronamide + paraquat, or use of early May application combined with a 2- to 3-week delay until seeding.

Title: Effects of Insecticides, Insecticide Rates, Seed Rates, and Existing Vegetation on No-till Alfalfa Establishment

Leaders: L.R. Vough, A.M. Decker, R.F. Dudley, J.H. McNemar, and T.H. Miller (University of Maryland and Beltsville Agricultural Research Center)

Investigations of the effects of insecticides and alfalfa seeding rates were continued by seeding three new experiments in late August 1981. In two of these experiments, alfalfa was seeded at 11.2, 16.8, and 22.4 kg/ha, and Furadan was placed in the furrow with the seed at zero, 11.2, and 16.8 kg/ha in a factorial arrangement. One experiment was seeded into cereal rye/weed stubble and the second into bluegrass sod. In the third experiment, a comparison was made among granular Furadan, flowable Furadan, and Advantage at two application rates.

There were no discernible visual stand differences among the various treatments in any of the three experiments. Stands were good to excellent in all but the bluegrass sod where all stands were poor. Stand counts were not made, but first harvest yields are scheduled for 1982.

Title: Corn Silage Yield Responses to At-Planting Application of Insecticide-Nematocide Materials

Leader: W.W. Washko (University of Connecticut)

A series of tests has been conducted on dairy farms in Connecticut to measure yield response to the insecticide-nematocides carbofuran and terbufos. The study began in 1973 and has continued through 1981. Most of the tests have been highly replicated (= or >8) with materials applied within 2 days after planting. Roots were examined for evidence of corn rootworm injury and, in 1980 and 1981, assays were made of nematode populations.

Positive yield responses to application of these materials have generally been measured, the increase in silage yield averaging 1.2 tons per acre over the period of the study. Root examinations indicated heavy insect feeding during the earlier years of the study but not in the 1979-1981 period. Lesion nematodes (*Pratylenchus* spp.) have been consistently detected, and assays indicate numbers increase at a slower rate through the growing season when either material is applied. Other species of nematodes detected have included *Tylenchorhynchus*, *Hoplolaimus*, *Criconomoides*, *Paratylenchus*, *Heliocotylenchus*, and *Longidorus*.

Title: Improving Land Utilization for Forage Production on Small Farms

Leaders: D.W. Koch, J.R. Mitchell, J.B. Holter, and N. Leonard (University of New Hampshire)

A study was initiated in 1980 in which corn, sorghum x sudangrass, hybrid sudangrass, Japanese millet, Chinese cabbage x turnip, red clover, birdsfoot trefoil, alfalfa, and orchardgrass were sod seeded on a rocky field with a pH of 5.4 and very low in major nutrients. The purpose of the study is to determine the potential of annual forages for interim production during a fertility building program, enhancing establishment of perennial legumes and maximizing length of grazing season. Prior to seedings, lime, P, and K were surface applied. In 1981, annuals were sown on half of the plots seeded to annuals in 1980, and the other half was no-till seeded with birdsfoot trefoil. All plots except corn were harvested in late July each year, and all plots were harvested in mid-September. Japanese millet was highest yielding (9.2 mt/ha) in 1980. Birdsfoot trefoil was highest yielding of the legumes in 1980 with 4.0 mt/ha. Yields of annuals in 1981 were similar for sorghum x sudangrass, but higher for the others, compared to 1980. The yield of Chinese cabbage x turnip was about 25% higher in 1981, even though the yield following the September harvest was not determined as in 1980, a period when 30% of topgrowth was produced. Seedling density and legume yield from birdsfoot trefoil in 1981 were not significantly different among previously grown annual crops. Compared to yields of birdsfoot trefoil seeded in 1980 into sod, yields of birdsfoot trefoil plots seeded into stubble of annual crops were slightly lower.

Title: Effect of Grazing Management and Fertilization on Botanical Composition of "Native" Pasture

Leader: W.B. Bryan (West Virginia University)

The objective of this experiment, initiated in 1979, is to study the effects of grazing management and fertilization, separately and₂combined, on pasture botanical composition. Plots of 400 m² are subjected to continuous, controlled (3 to 6 times/year), and controlled (once a year) grazing with cattle. Fertilizer treatments are (1) control and (2) 50 kg/ha/year P and 4,000 kg/ha/year ground limestone. Botanical composition and dry matter yields are assessed before each grazing and soil samples taken yearly.

Title: Pasture Production Evaluation with a Cow-Calf Herd

Leader: E.R. Jones (Delaware State College)

Evaluation of all-forage, year-round grazing was continued in 1981. Progeny of Hereford, Angus, and Hereford-Angus cows bred to an Angus bull were calved in 1981. Thirty-one calves were produced from 33 cows grazed on various forages with no supplement; brood cows were flushed on spring forage growth before exposure to the sire on May 1. Cows averaged 390 kg before the grazing season and 431 kg at weaning; the average 205-day adjusted-weaning weight was 158 kg.

Although the April to September rainfall (60 cm) was near normal (64 cm), soil moisture was often limited throughout the growing season. Rainfall during the December 1980 to March 1981 period was 13 cm and 11 cm during July and August 1981. All stockpiled forage was consumed by February 1, 1982.

Twelve 1.8 ha pastures were utilized for the research. Two tall fescue pastures produced an average of 737 grazing days (GD)/ha. A third tall fescue pasture provided 479 GD/ha during spring and fall and 51 q/ha of shelled corn during the summer. Three orchardgrass pastures produced an average of 675 GD/ha, two Vantage reed canarygrass pastures produced an average of 700 GD/ha, and a common reed canarygrass pasture had 743 GD/ha. Midland bermuda grass, alfalfa, and Kenhy-Ladino white clover pastures produced 798, 788, and 412 GD/ha, respectively. Average forage digestibilities (IVDMD) at times of grazing were 59, 60, 57, 51, 58, 63, and 64%, respectively, for tall fescue, orchardgrass, Vantage reed canarygrass, common reed canarygrass, Midland bermuda grass, alfalfa, and Kenhy-Ladino white clover.

Title: Establishment of Legumes by Sod-seeding

Leaders: Ragnar Eltun and R.C. Wakefield (University of Rhode Island)

Alfalfa, red clover, and birdsfoot trefoil were seeded into sods of orchardgrass, timothy, and Kentucky bluegrass following application of glyphosate. Inhibition of legumes was noted in all sods, particularly in spring seedings of timothy. Alfalfa was inhibited more than red clover or birdsfoot trefoil. Inhibition decreased from 0 week to 1 week to 2 weeks following spraying. Some inhibition remained after 4 weeks. Further research is planned to determine the possible roles of glyphosate toxicity and allelopathy in decaying grass sods.

Title: Forage-Livestock Systems for Land with Soil and Site Limitations

Leaders: R.C. Wakefield and C.D. Sawyer (University of Rhode Island)

Adaptation Studies: Species seeded on an acid, infertile, and droughty Class II soil in 1978 were evaluated for yield of forage. Yields of warm-season grasses were much greater than cool-season grasses as stands of big bluestem, indiangrass, and switchgrass continued to improve while tall fescue and orchardgrass declined. Nitrogen fertilizer substantially increased yields of all species. Stands of crownvetch continued to improve, while birdsfoot trefoil declined and alfalfa and red clover had disappeared. Original seedings of Caucasian bluestem, milkvetch, and bigflower vetch failed to develop.

Establishment Studies: No-till seedings of birdsfoot trefoil with insecticides were again established. Results indicated that there were no differences between paraquat and glyphosate in birdsfoot trefoil establishment. Use of carbofuran at time of seeding was more advantageous with summer seedings compared to those made in spring.

Title: Evaluation of Purpletop (Tridens flavus L. Hitchc.) as Forage for Beef and Sheep

Leaders: B.S. Baker and Neal Boggess (West Virginia University)

Studies on management and persistence of purpletop in indigenous swards were continued in 1982 to determine the suitability of incorporating purpletop in forage programs for beef and sheep. Nitrogen fertilizer was applied to established swards containing purpletop at rates of 0, 25, 50, or 75 kg/ha in early April and/or early June. Swards were managed for hay production and harvested in early June and September. The June harvest resulted in yields as high as 6,000 kg of dry forage/ha. Most of the forage in the June harvest was cool-season grasses, especially at the higher rates of N. The September harvest resulted in yields as high as 3,000 kg of dry forage/ha, with purpletop accounting for 50% of the dry weight. Yields in 1981 were similar to those found in 1979 and 1980. The percentage of purpletop in swards decreased slightly in 1981, with a corresponding increase in cool-season grasses. Yield and persistence studies will continue in 1982 on the same swards.

Purpletop harvested at anthesis was found to contain 0.21% P, 1.44% K, 0.22% Ca, and 0.14% Mg. Digestibility of purpletop is being determined.

Title: Pasture Utilization for Beef Production--A Comparison of a Conventional and an Innovative Cow/Calf System

Leaders: E.C. Prigge, W.B. Bryan, and R.O. Burton (West Virginia University)

Two systems of beef cow/calf production will be compared in a replicated year-round grazing and feeding experiment. The objectives of the experiment are to determine production levels and economic feasibility of a conventional and an innovative cow/calf system. The conventional system is designed to represent present farmer practices. Native pastures will be grazed continuously and cows wintered on hay cut from a meadow area. The innovative system is a combination of "improved" practices including sod-seeded legumes, forward, rotational, and extended grazing. Ten hectares have been assigned to each system. This has been divided into two replicates, each consisting of 2 ha of meadow and 3 ha of native pasture. Initially, five cows will be assigned to each replication, but cow numbers will be adjusted according to forage production. Inputs of labor and capital will be recorded. Output of animals and any hay sold will be noted. Amount of forage produced and consumed, milk production, and soil fertility will be monitored. Economic feasibility will be analyzed using budgeting and linear programming techniques. Data will be used to determine optimal management strategies in the context of whole-farm situations.

Meadows for the experiment were laid out and seeded in 1981. Cows will be introduced to the area in 1982, and the experiment will continue for at least 3 years.

Title: Comparison of Methods of Legume Establishment in Hill Pasture Under Rotational Grazing

Leader: W.B. Bryan (West Virginia University)

Forage production from hill pastures is often low and of poor quality. Increasing the legume component of such pastures can lead to improvements because of increased atmospheric N fixation and because legumes are usually better quality feed. In the experiment, three methods of seeding three legumes into a hill pasture were examined. These were broadcasting the seed by hand, sod seeding with a Zip seeder, and sod seeding with a Power-till seeder. The legumes used were red clover (Trifolium pratense), white clover (T. repens), and birdsfoot trefoil (Lotus corniculatus). The effects of paraquat (1, 1'-dimethyl-4,4'-bipyridium dichloride) and soil amendment (P and lime) on legume establishment were also examined. Two nonseeded control treatments were included, N (112 kg/ha/year) and nothing.

The experimental area was a Kentucky bluegrass (Poa pratensis/Agrostis spp.) pasture with up to 30% slope, initial soil pH was 4.8, and soil P was low. The experiment was designed as a randomized complete block with split plots, and three blocks. Cattle grazed the experiment as one paddock every time the pasture reached a height of 10 to 15 cm. Botanical composition was noted visually for a 4-year period.

There were no differences in method of seeding except that Power-till plots had a greater percent total legume than Zip-seeded and broadcast over the first 2 years. Seeding a legume increased the percent total legume for 2 years but did not differ from unseeded plots in the third and fourth years. Red clover plots had over 40% total legume in the second year, but by the fourth year there was no difference between legumes in percent total legume, and all seeded treatments had over 15%. Paraquat, lime, and P increased percent total legume. The effect of paraquat lasted for 2 years, whereas that of lime and P lasted throughout the experiment.

Title: Crop Production Planning for Dairy Farms

Leaders: C. Smith, D.W. Koch, and G. Frick (University of New Hampshire)

The main goal of this project was to develop a computerized crop planning system, available to researchers and extension personnel, to aid farmers in evaluating cropping alternatives for their farms. The crop planning system enables the user to construct a linear programming (LP) model tailored to an individual farm or set of experiments. The system calculates annual nutrient requirements for the herd, according to milk production level, and defines cropping activities to compete for acreage in each of five land categories. Forage establishment costs and annual production costs are calculated, as well as protein and energy costs per unit of dry matter. The most profitable combination of cropping activities and purchased feeds is selected, through LP techniques, to balance the dairy ration. An economic analysis is also provided. The program may be used by extension personnel to assist dairy farmers in long- and short-range planning. Crop researchers can evaluate experimental results from an economic perspective. A copy of the program and a user's manual may be obtained from Mr. George Frick, Institute of Natural and Environmental Resources, James Hall, University of New Hampshire, Durham, NH 03824.

Title: Evaluation Studies of Important Horticultural and Agronomic Crops

Leaders: W.M. Murphy and B.R. Boyce (University of Vermont)

Oat Forage: Farmers are expressing renewed interest in using small-grain companion crops in forage establishment. Oats grown for hay or ensilage has the advantage of being harvested sooner than oat grain and, consequently, removing competition from the forage seeding earlier in the season. The effects of seeding rate and N rate on forage yield of two oat forage varieties were studied during 2 years at three locations to determine which combinations would be optimum for production. Seeding rates of 78 and 56 kg/ha and N rates of 34, 22, and 11 kg/ha were used. No significant differences in yield were observed, indicating that the lower rates of seeding and N could be used without decreasing yield.

Sunflowers for Silage: In some areas of Vermont, conditions are not well suited for growing corn. Sunflowers are more cold tolerant and drought resistant than corn and might be useful for silage in those areas. Nine varieties selected for leafiness were grown to determine forage yield at two different locations in 1980 and 1981. Silage (32% DM) yields averaged 29.6 ton/ha in 1980 at Shelburne in central Vermont, and 24.9 ton/ha in 1981 at W. Glover in northeastern Vermont. Although yields were only about one-half of those usually obtained from corn, sunflowers may be useful for producing ensilage under drought conditions.

Title: Forage-Livestock Systems for Land with Soil and Site Limitations

Leaders: D.W. Allinson and R.A. Peters (University of Connecticut)

Yields were obtained from eight species in the adaptation study that was established on a poorly drained site in 1978. Of these eight species, six were grasses. The grasses were fertilized with 0 or 75 kg N/ha. Nitrogen was applied in a single application. All of the grasses showed a positive response to nitrogen application. When fertilized, grass yields were greatest for big bluestem, followed in order by switchgrass, orchardgrass, tall fescue, reed canarygrass, and redtop. Where no fertilizer was applied, the grass yields ranked in the order of big bluestem, tall fescue, orchardgrass, reed canarygrass, redtop, and switchgrass. The only two legumes remaining in the study were alfalfa and kura clover. Yields from these two species were 8.0 and 6.2 mt/ha, respectively. Yields from alfalfa were equivalent to the greatest yields obtained from the fertilized grasses. The yield from kura

clover was greater than any of the unfertilized cool-season grasses. Samples of species harvested in 1980 have been analyzed for Ca, Mg, P, K concentrations, and IVDMD. Kura clover consistently had the highest IVDMD. Greenhouse evaluations of this latter species have been initiated.

No-tillage seedlings of Blackwell switchgrass and Kentucky 31 tall fescue were seeded on May 18 and June 2 in a sod killed by glyphosate. Stands obtained were erratic with tall fescue establishing more readily than switchgrass. Furadan markedly increased stands of switchgrass from 14% cover with no treatment to 70%.

Title: Forage-Livestock Systems for Land with Soil and Site Limitations--Establishment Phase, Legumes

Leader: W.B. Bryan (West Virginia University)

Yield and quality of hill pasture may be improved by introducing a legume. Success depends on using a low-cost technology. Sod seeding is used extensively, but reasons for success or failure in legume establishment are not well understood. This experiment was conducted to compare the establishment of Kenstar red clover (Trifolium pratense L.) and Empire birdsfoot trefoil (Lotus corniculatus L.) sod seeded with different combinations of herbicides, insecticide, P, and lime in spring and fall. There were 19 treatments, including three nonseeded controls receiving no fertilizer; P and lime; and P, N, and lime. The experiment was carried out in 1978 on a site with soil pH 4.8 and in 1979 on a site with soil pH 5.3. Seedling counts were made 4 to 6 weeks post seeding. Yield was determined at first harvest after the first winter.

There was no difference between legumes in seedling numbers where existing vegetation did not compete strongly with seedlings, but there were more seedlings of red clover where competition was strong. Red clover plots yielded more and had a higher percent total and seeded legume than birdsfoot trefoil. Lime, P, and herbicide had no effects on seedling numbers, and only lime increased harvested yield and percent seeded legume on the less fertile site. Insecticide increased seedling numbers only where competition from existing vegetation was low. Spring seeding was best where competition was low and fall seeding best where it was high.

Title: Sod Seeding of Legumes on Land with Soil and Site Limitations

Leader: R.G. Hall (University of Maine)

A grass sod consisting of Kentucky bluegrass, timothy, smooth brome grass, orchardgrass, and reed canarygrass was sod seeded to Arlington red clover and Empire birdsfoot trefoil in June 1980. Each legume was sod seeded using eight treatment combinations of lime, P_2O_5 fertilization, contact and residual herbicides, and an insecticide. The treatment combinations included (1) P_2O_5 at 224 kg/ha broadcast (Pbc) or P_2O_5 zero-check (Po); (2) contact herbicide, paraquat at 0.84 kg ai/ha, both banded (Cb) and broadcast (Cbc), and a zero-contact herbicide check (Co) which was mowed to a 5 cm stubble; (3) residual herbicides, 2,4-D plus diclofop at 1.12 and 1.40 kg ai/ha, respectively, and broadcast separately (Rbc), and a zero-residual herbicide check (Ro); and (4) an insecticide, Dyfonate broadcast at 4.5 kg ai/ha (Ibc), and a zero-insecticide check (Io). Also included were three zero-seeded checks fertilized with (1) lime at 4.5 t/ha, P_2O_5 (224 kg/ha), and K_2O (168 kg/ha); (2) zero-lime, P_2O_5 , and K_2O ; and (3) lime, P_2O_5 , K_2O , and nitrogen (168 kg/ha) in an equal split application.

Forty days after seeding, the highest seedling density of red clover was obtained from the Pbc Co Rbc Ibc and Pbc Cbc Rbc Ibc treatment combinations (138 and 148 seedlings/meter row, respectively), while the lowest densities were obtained from the Pbc Cb Rbc Ibc and Pbc Cb Ro Ibc combinations (108 and 76 seedlings/meter row, respectively). In trefoil, the highest density was obtained from the Po Cb Rbc Ibc combination (124 seedlings/meter row), while the lowest densities were obtained from the Pbc Co Rbc Ibc, Pbc Cb Rbc Ibc, and Pbc Cb Rbc Io combinations (84, 84, and 76 seedlings/meter row, respectively). Sixty days after seeding, total dry matter yields were not significantly different among the red clover, trefoil, and zero-seeded treatments.

In 1981 there were no differences in legume dry matter (DM) yields between treatments in grass sod seeded to clover or trefoil. Legume DM was significantly higher in clover than in trefoil, with the DM yields being higher at the second harvest compared to the first harvest in both legumes. Among the clover and trefoil seeded treatments and the zero-seeded treatment, there were no significant differences in grass DM yields. Grass DM yields were significantly higher at first harvest compared to second harvest among all treatments. There was no difference in weed DM yields between treatment combinations seeded to red clover. In trefoil the Pbc Co Rbc Ibc, Pbc Cb Rbc Ibc, and Pbc Cbc Rbc Ibc (unlimed) treatment combination resulted in significantly higher weed DM yields

compared to the other combinations. In turn, the low weed DM yields obtained from the sod-seeded clover treatments were significantly lower than the low DM yields obtained from the trefoil-seeded treatments. In 1981, there were no significant differences in legume plus grass DM yields among the eight treatment combinations imposed during sod seeding of red clover. In contrast, the Pbc Co Rbc Ibc and Pbc Cb Rbc Ibc combinations were significantly lower than the other combinations used in the sod seeding of trefoil. The legume plus grass yields from sod-seeded clover were significantly greater than the highest yields from sod-seeded trefoil. The lowest legume plus grass yields from sod-seeded trefoil were similar to the grass yields obtained in the zero-seeded check treatments.

The sod seeding of red clover appeared to be more successful than the seeding of trefoil. It would appear that the Pbc Cb Ro Ibc and Pbc Cbc Ro Ibc combinations would be the best treatment combinations to use when establishing either red clover or trefoil.

Title: Forage-Livestock Systems for Land with Soil and Site Limitations

Leaders: A.M. Decker, R.F. Dudley, and T.H. Miller (University of Maryland)

The first of two no-till experiments considered seeding date of Blackwell switchgrass and Ky-31 tall fescue. Seeding dates were April 9, May 5 (early boot of common orchardgrass), and May 22. Glyphosate was broadcast at 1.7 kg/ha just prior to seeding. Each variety was seeded with or without Furadan in the row (2.5 kg ai/ha). Plant counts 2 months after seeding showed April 9 to be the best date for fescue establishment, and May 5 was best for switchgrass. Establishment was poor for both species on the last date. Furadan improved establishment of both species; the best response was at the best seeding for each species. Plant height and stand ratings on July 29 followed patterns similar to stand count data.

In a second experiment seeded May 22, switchgrass was seeded into a grass sod which had been broadcast sprayed with glyphosate. Treatments were atrazine broadcast and Furadan in the row at seeding in a factorial arrangement. The best treatment was with both atrazine and Furadan, and the poorest treatment was with atrazine alone; there appeared to be a synergistic effect. Furadan improved switchgrass stands without the atrazine, but they were much better when both were used.

Title: Forage-Livestock Systems for Land with Soil and Site Limitations

Leaders: D.W. Koch (University of New Hampshire)

Results of a uniform (NE-114) establishment study with warm- and cool-season grasses indicated that tall fescue established more readily than switchgrass following seeding without tillage into a weak sod on a low-fertility field. There were greater seedling densities and larger seedlings 10 weeks following seeding with tall fescue, compared with switchgrass. Early seeding (May 12) was best for both species. There was a beneficial response to carbofuran, especially at the early seeding date. Results of another uniform study established in 1981 showed that broadcast glyphosate resulted in greater switchgrass seedling density than glyphosate banded at the time of no-till seeding. Atrazine and carbofuran tended to improve seedling density and seedling growth. Response to herbicides can be related to the severe competition of established dandelions in plots on which only one-third of the area was treated with glyphosate (banded) and in plots broadcast treated with glyphosate but not receiving a residual material (atrazine). With the latter treatment, seedling dandelions provided severe competition.

Title: Plant Density and Nitrogen Interactions of Intercropped Corn-Cowpea for Silage

Leaders: S.J. Herbert and D.H. Putnam (University of Massachusetts)

Corn and cowpea were interplanted in the same row at 91-cm spacings, with five levels of each corn and cowpea density and five levels of nitrogen fertilization. The experimental design was a central composite with internal replication at the central treatment level of each factor. Nitrogen rates varied 22 to 202 kg/ha, corn densities 0 to 114,000 plants/ha, and cowpea density 0 to 344,000 plants/ha.

Increasing corn density increased total silage yield and corn contribution to the mixture. Increasing cowpea density had little effect on total silage yield, although there was a small increase in cowpea contribution in the total yield. There was a nitrogen corn density interaction where increasing nitrogen increased silage yield at high corn densities. A high corn density was required for a similar forage yield of the intercropped corn-cowpea compared with monoculture corn. At these high corn densities, cowpea contribution to yield was suppressed.

Title: Chemical Drying and Preservation of Hay

Leaders: L.R. Vough, J.H. McNemar, A.M. Decker, and T.H. Miller (University of Maryland)

The latest development in hay making is a chemical method to hasten drying in the field. The material is applied at the time of cutting as a low pressure spray. The chemical mixture contains both a drying agent and a preservative.

Preliminary field trials were conducted on alfalfa in August and October 1981. Drying time of treated alfalfa hay was generally reduced by one day--treated hay was baled 24 to 48 hours earlier than untreated hay in each of four tests. In the two August trials, treated hay was baled the day after cutting, while untreated hay was not ready to bale until the second day after cutting. In two trials conducted in mid-October, treated hay cut on day 1 was baled on day 3 while untreated hay was not ready to bale until day 4. The same treatments were repeated on hay cut day 2. The treated hay was likewise baled on day 3 (one day after cutting) while the untreated hay was baled on day 4. Since day 1 was not a good hay drying day, hay cut day 2 was ready to bale at the same time as hay cut on day 1. In most cases, the moisture contents of both treated and untreated hays were 20% or less at the time of baling.

In addition to reducing drying time, therefore reducing the chances of rain damage, another advantage of the material is that it is not corrosive and not hazardous to handle as is the case with organic acid preservatives. Estimated cost of the material is \$8 to \$9 per ton of dry hay. The product name is CONSERVIT, and it will probably be available to farmers in the Northeast in 1983.

Title: Forage Management

Leader: G.M. Dunn (University of New Hampshire)

The following varieties and strains of brome grass, orchardgrass, and timothy were seeded May 2, 1979: Rebound, Saratoga, Tempo, and B-8 brome grass; Kay, K3-9, and Pennlate orchardgrass; and Climax, Clair, Basho, and 009 timothy. A split plot design was used with three replications, with each grass variety seeded alone at two nitrogen levels (227 and 454 kg/ha ammonium nitrate) and in a mixture with Iroquois alfalfa. The objective was to evaluate the productivity of new strains and varieties of the three grasses alone at two nitrogen levels in comparison to a mixture with Iroquois alfalfa.

Plot size was 1.5 x 4.8 m, and a 0.9 m swath was taken at 7.5 cm height from the middle of each plot for yield determinations. A 500 gm sample was collected for dry matter determination and for analysis of crude protein. Three harvests were made each year in 1980-81 on approximately June 8, July 30, and September 25.

Two year mean yields and percent crude protein were 8.94, 10.36, and 13.29 mt/ha and 9.6, 9.5, and 14.4%, respectively, in the two nitrogen levels and the mixture. Yield, percent crude protein, and seasonal distribution of yield were all significantly improved in the mixture. Bromegrass and timothy were superior to orchardgrass seeded alone. Within a species, varietal differences generally were small and nonsignificant. These results tend to substantiate recommendations for use of simple mixtures of productive grasses and legumes in forage production.

Title: Pasture and Sheep Flock Management for the Production of Market Lambs

Leaders: B.S. Baker and P.E. Lewis (West Virginia University)

It was determined in earlier studies that improved permanent pastures at the higher elevations in the Appalachian Mountains were superior to any annual forages tested as feed for lambs. This research was undertaken to evaluate five feeding systems for lambs. The objectives were to determine rate of gain, feed efficiency, and feed cost. The feeding systems evaluated were: (a) lambs weaned at 90 days of age and fed a ground feed containing forage and grain in a dry lot situation; (b) lambs weaned at 90 days of age, grazed on an improved permanent pasture containing 25% or more legumes, and provided free choice the ground feed containing forage and grain; (c) lambs weaned at 90 days of age and grazed on an improved permanent pasture; (d) lambs remaining with ewes on improved permanent pasture, but at 90 days of age provided the ground feed free choice on a creep feeding basis; (e) lambs remaining with ewes and grazed on an improved permanent pasture.

Lambs in treatment (a) gained 0.25 kg and consumed 2.7 kg of feed/day. Lambs in treatment (b) gained 0.25 kg and consumed 2.3 kg of feed/head/day. Lambs that were weaned and grazed on permanent pasture (treatment c) gained 0.15 kg/head/day. When lambs were allowed to graze with ewes, but had access to creep feed (treatment d), gains were 0.22 kg/head/day, while the feed intake was 2.5 kg/head/day. Lambs on pasture with ewes gained 0.18 kg/head/day. The cost of ground forage and grain/kg of gain varied from 81 to 99 cents. The price of lambs was only slightly higher than ground feed cost during 1981. The experiment will be repeated in 1982.

Title: An Evaluation of Cattle, Sheep, and Goats as Biological Agents to Control Weeds and Scrub in Hill Pastures

Leaders: T.A. Mills and W.B. Bryan (West Virginia University)

Six management and two fertilizer treatments are being applied as a four replicated 6 x 2 factorial to a weed- and scrub-infested hill pasture. The management treatments are: (1) grazing with cattle, (2) grazing with sheep, (3) grazing with goats, (4) cut and grazing with cattle, (5) herbicides and ungrazed the first year, (6) control. Fertility treatments are: (1) none and (2) lime and P. In the second year, the second fertility treatment will be overseeded with red clover. Plots are 9 m² and grazed rotationally. The first year's results show that the electric fence can successfully control all three species of grazing animal. Goats selectively browse leaves and stems of hawthorn and blackberry and, when forced, graze herbaceous material. Sheep select herbaceous material but later eat the hawthorn and blackberry leaves. Cattle showed strong preference for grass, but a treading effect in some areas eliminated some blackberry canes and small hawthorns. Cattle plots contained more herbaceous weeds (especially ironweed) than sheep and goat plots. All grazing treatments had marked effects in reducing weeds and scrub compared to the control.

Title: Intercropping Corn with Polebeans and Cowpeas

Leaders: S.A. Peprah and W.B. Bryan (West Virginia University)

An experiment was conducted comparing the effects of planting date and nitrogen on DM yield of corn-polebean and corn-cowpea intercrops. Corn and legumes were planted in the same row at 67,000 and 208,000 plants/ha, respectively. Early, mid, and late planting dates were used, and on each of these dates corn was planted alone and simultaneously with the legume. Other treatments included planting the corn first and the legume on the next date and vice versa.

It was found that intercropping increased yield per unit area. Earlier planted corn, followed by the legume at a later date, gave best yields. Nitrogen increased corn yield but not legume yield. The yield of corn grown without N fertilization was increased by intercropping.

Title: Evaluation of Year-round Grazing Systems

Leaders: A.M. Decker, R.F. Dudley, J.H. Vandersall, L.R. Vough, R.A. Erdman, T.H. Miller, and James Bond
(University of Maryland and Beltsville Agricultural Research Center)

Three summer pasture mixtures (red clover-trefoil-orchardgrass; red clover-crownvetch-orchardgrass; and red clover-orchardgrass) and two winter pastures (tall fescue-nitrogen and tall fescue-sod-seeded red clover) were evaluated for year-round pasture using dairy replacement heifers, light dairy steers (225 kg), and heavy dairy steers (400 kg) as test animals. The large steers were on pasture during the winter and until the end of the spring flush of growth, while the small steers and heifers were on pasture only during the summer.

The summer pastures were in the third grazing season following no-till legume establishment. As a result, the red clover stands had thinned considerably. Liveweight gains were similar for all three summer pastures but were highest for the trefoil, followed by crownvetch and red clover, respectively. Heavy steers were moved from the summer to the winter pastures October 6, 1981, where they remained throughout the winter. No supplemental feed was provided except for some hay during a 2-week period in January when an ice crust covered the snow. Animals came through the winter in excellent condition, gaining 0.46 and 0.34 kg/animal/day and 165 and 179 kg gain/ha for the fescue-clover and fescue-nitrogen pastures, respectively; the higher carrying capacity of the fescue-nitrogen resulted in the higher gain/ha.

Title: Influence of Insecticides and Fertilizers on No-tillage Alfalfa Establishment on Three Widely Different Soil Fertility Levels

Leaders: A.M. Decker, L.R. Vough, R.F. Dudley, T.H. Miller, and J.H. McNemar (University of Maryland and Beltsville Agricultural Research Center)

Alfalfa was no-till seeded on April 28, 1981, into plots that have been maintained at three fertility levels but similar pH levels over a period of years. Low fertility plots have been fertilized at one-half soil test recommendations for P and K, medium fertility plots at actual soil test recommendations for P and K, and high fertility plots at double soil test recommendations for P and K. The seeding treatments were (1) seed only (S), (2) S + P in row (PR), (3) S + P over row + Furadan in row (F), (4) S + F, (5) S + PR + F, (6) S + P + Mesuroi (M), (7) S + P + F + M, and (8) S + P and N in row + F.

Seedling alfalfa stand counts, plant height, and seedling weights were determined in mid-June. Stand ratings were also made at this time. Yields were not made during the seedling year because of very severe annual weedy grass invasion.

Stand counts were extremely erratic, and no treatment effects on stand density could be determined except that plant numbers tended to be slightly higher at the higher fertility levels. Nitrogen in the row significantly increased plant height and plant weight at all fertility levels. The taller plants and the larger plants were usually associated with nitrogen plus Furadan in the row. Phosphorus in the row increased plant height and weight only at the low fertility level, and the highest response was where Furadan was placed in the row with the seed and phosphorus.

Title: Soil-Plant-Environment Relationships in the Productivity and Quality of Forages

Leaders: L.E. Lanyon and W.C. Stringer (The Pennsylvania State University)

Studies of soil fertilization systems for alfalfa and orchardgrass in Pennsylvania were continued this year. Responses by alfalfa to K from 175 to 350 and P of up to 45 kg/ha/yr were recorded, especially under conditions of low initial fertility. Differences in alfalfa yield (from 2 to 5 t/ha) were measured between similar treatments applied to soils of different series. Reduced soil drainage had a depressing effect on yield and stand density of alfalfa even though no Phytophthora root rot was observed. Observations of soil temperature and moisture in the imperfectly drained soils throughout the year corroborate their morphological characteristics and will be considered in evaluating alfalfa production potentials of these soils. Evaluation of selected P and K treatments indicates that the dynamics of the soil nutrient pools are different. Plant removal, available and other unaccounted for K is proportional to the added K. Preliminary results for P show some increase in removal, an increase in available, but the unaccounted for portion approaches a limit and is not proportional to added P. Results of modifying soil Ca/Mg ratios indicate that alfalfa and orchardgrass mineral contents may be manipulated, but yields are not related to the ratios in the range studied. Foliar toxicity resulting from B applied in solution to alfalfa was observed at high rates, but limited yield effects were observed.

Title: Increasing the Use of Legumes in Crop Rotations

Leader: W.M. Murphy (University of Vermont)

Alfalfa: Alfalfa does not grow as well as it previously did in Vermont; new seedlings frequently do not survive their first winter. This study was begun to determine the reasons for lack of establishment vigor that has been observed. As a first step, nine varieties were established at five locations. At three of the locations, seeds were treated with MolyCoThi. No differences were observed in yield in either the seeding year or subsequent year due to MolyCoThi at any of the locations. Varieties grew equally well at two locations; three varieties produced less forage than others at one location in 1981.

Clovers: Factors affecting establishment of red and white clovers in acid, infertile soils are being studied in an effort to introduce them into steep land soils best suited for permanent pasture. Dutch white clover was grown in the greenhouse on core samples of four soils treated with combinations of B, Cu, Mg, Mo, P, S, and Zn. Lime pelleting of seed was also a treatment. All soils received a blanket treatment of K. Positive responses of plant growth and nodulation occurred, especially with lime pelleting, Mo, and P. An attempt was made to establish red and white clovers in the field under these treatments, using sheep to expose the soil. The experiment failed because we did not have direct control of the sheep and could not graze when or as intensely as we wanted to. We will try again this season, using light rototilling to prepare a seedbed.

Rhizobia occurring naturally in the soils are being characterized and selected for nodulating and N-fixing effectiveness. Selected rhizobia will be applied in the field in 1983.

A current greenhouse study involves pelleting Dutch white clover seed with lime, P, and mycorrhizal fungi on two soils. The fungi are from a culture selected in Oregon and may help the plants take up otherwise unavailable soil P. These treatments will be tested in the field beginning in April 1982.

Title: Pasture Utilization for Beef Production--Grazing Season Extension

Leaders: E.C. Prigge, W.B. Bryan, and R.O. Burton (West Virginia University)

The objective of this experiment is to evaluate the potential of Kenhy tall fescue and Potomac orchardgrass for early spring and late fall grazing. The effect of such grazing on hay production is also being evaluated. The following four treatments are applied to both grasses:

Treatment	Early Spring Grazing	Hay Cut	Aftermath Hay	Late Fall Grazing
1	X	X		X
2		X	X	
3	X	X	X	
4		X		X

Pastures are 0.25 ha in size and were established in the fall of 1979 in four replicates. In 1981, 75 kg N/ha were applied in early spring and again after the first hay cut and grazing was initiated on April 23. Heifers and steers were used to graze. Estimated dry matter yield of tall fescue was higher than that of orchardgrass at all times. Plots grazed in early spring yielded less hay in June; however, aftermath yield in September was greater in plots grazed in early spring and in October. There was no difference in estimated dry matter yield between plots grazed in early spring and those not grazed.

This experiment will continue in 1982.

Title: Component Analysis and Synthesis of Forage-Dairy Production Systems

Leaders: G.W. Fick, R.A. Milligan, P.A. Oltenacu, R.E. Pitt, and C.J. Sniffen (Cornell University)

Regional Research Project NE-132 has the objectives of (1) developing and refining component models and (2) synthesizing component analyses into a research-oriented representation of the forage-dairy production systems of the Northeast. The Cornell University contributions come from agronomy, agricultural engineering, animal science and nutrition, and agricultural economics.

A simplified alfalfa growth model was developed and tested. The model was validated using yield and quality data collected on three soil mapping units and three cutting managements over 2 years. Dry matter yield predictions have an R^2 of 0.62 and

an RSD of 0.87 Mg ha^{-1} . Digestibility and crude protein R^2 for predictions were only 0.25 and 0.13, respectively, with RSD levels of 3 and 5%. Continuing work is focusing on the development of more accurate mechanistic models of quality.

Engineering-related research concentrated on the application of dessicants to fresh-cut legumes to increase the rate of drying and on modeling the conditions within a bunker or tower silo. Improved drying rates of legumes like red clover would allow for increased use of these crops in the farming systems of concern. The application of dessicants has included laboratory and field studies. Drying time was reduced using mixtures of potassium carbonate, methyl ester, and a surfactant X-77, although drying time was not reduced as much in field studies as in laboratory studies. The purpose of the modeling of silo conditions is to develop equations that allow the conditions in a full-scale silo to be duplicated in the laboratory in small silo chambers. Expressions were derived for the pressure and density of the silage at the silo wall and in the center of the silo at any depth.

The biological model of the dairy cow being developed by David Mertens, University of Georgia, and Charles Sniffen is progressing well but is not yet completed. The biological specification is nearly complete. Some components have been programmed, and it is expected that the model will be operational in early 1982.

The procedure has been formulated for the systems analysis component of NE-132. It was outlined and distributed to project participants, and details of activities and individual responsibilities were assigned at the annual meeting. Briefly, the procedure defines a representative-farm approach, with major emphasis on the productive and economic effects of forage composition for the farm.

Title: Planting Patterns and Densities of Intercropped Corn-Soybean for Silage

Leaders: D.H. Putnam, S.J. Herbert, and M.I. Poos (University of Massachusetts)

The objective of two experiments in 1981 was to evaluate the effect of plant density and planting patterns on the yield of intercropped corn-soybean for silage. In experiment I, corn was planted at low, normal, and high densities (4.5, 6.7, and 9.0 seeds/m of row) both in monoculture (91 cm row width) and in two intercropped patterns, with alternate rows or every third row of corn being replaced by two rows of soybeans 35 cm apart. Soybean density was 36 seeds/m of row, and there was a soybean monoculture at the same density.

Silage was measured at physiological maturity of corn, when soybeans were at the R5 stage of maturity. Soybean monoculture silage yield was 23.5 t/ha. Corn monoculture yields were similar, 60.8, 62.7, and 62.0 t/ha for low, normal, and high densities. The alternate corn-soybean (2 rows) pattern yielded 47.1, 54.7, and 59.6 t/ha, and the corn-corn-soybean (2 rows) pattern yielded 52.6, 61.1, and 61.1 t/ha for low, normal, and high density corn rows, respectively. The higher densities needed in intercropping to maintain silage yield reduce the soybean contribution in the mixture. Corn compensates for this loss of soybean yield. LER's of intercropped systems were greater than 1.

The second experiment, a systematic design, combined nine corn densities and 13 soybean densities in 117 treatment combinations where alternate rows of corn were replaced by double rows of soybeans as in experiment I. Corn densities ranged from 4 to 16 plants/m² and soybeans from 15 to 85 plants/m². A maximum yield of 68 t/ha was achieved with the highest corn densities and medium soybean densities, although soybean density had a minor effect compared to corn density.

In both experiments, the upper limit of corn density in alternate corn-soybean (2 rows) rows was not explored. The percentage of ear in the silage for this planting pattern increased in both experiments with increased corn density. The converse occurred in corn monoculture.

Title: Alfalfa Production and Management in Relation to
Insect Control and Weather Patterns

Leaders: G.W. Fick and B.A. Kalu (Cornell University)

The objectives of this research include the development of computer models of alfalfa production and quality that can be used in systems studies of insect control in the alfalfa agroecosystem. Conventional field research and dynamic computer simulation techniques are combined to develop and test the models. In previous years, three alfalfa growth models have been developed under the general name ALSIM. In order of increasing complexity, they are called LEVEL 0, LEVEL 1, and LEVEL 2.

In the present year, a statistical model-testing package was compiled, and it has proven helpful in evaluating the ALSIM series of alfalfa growth models. The LEVEL 2 version of ALSIM appears to be more accurate than the other versions in predicting yield. The LEVEL 1 version overestimates yield and is really a potential yield predictor for optimal regional resources. The LEVEL 2 model has been documented and is ready for linkage to pest models. It will be superior to LEVEL 1 where estimates of summer production are important and summer

drought stress limits production. The very simple LEVEL 0 model will be useful in general studies of management of the alfalfa enterprise, but it lacks detail needed to simulate pest interactions. Statistical models of alfalfa quality have been improved enough to add quality to the economic analysis of pest management strategy, but mechanistic models for predicting the dynamics of alfalfa quality are still needed.

A substantial data base for developing mechanistic models of alfalfa quality has been assembled and intensive effort in that area is planned. Field trials of alfalfa stand life have emphasized the importance of soil drainage and associated species. More controlled experiments in the greenhouse and growth chamber are planned or underway to investigate the details of the interactions, including interactions with pests.

Title: Exploitation of Legumes in Forage Production

Leaders: W.C. Templeton, Jr., L.E. Sollenberger, and R.R. Hill, Jr. (U.S. Regional Pasture Research Laboratory and The Pennsylvania State University)

Herbage-nitrogen analyses of forages harvested from two small-plot experiments during 1980 were completed, and yields of nitrogen in harvested grass, legume, weed, and volunteer-legume components were determined. Compared to perennial ryegrass swards, seeded in August 1979 and receiving 0 to 400 lb/a N annually, a mixed alfalfa-ryegrass sward produced in 1980 almost as much N in harvested forage as did ryegrass receiving 400 lb/a of N. Red clover replaced 200 to 300 lb/a of N applied to ryegrass, while birdsfoot trefoil-ryegrass N yields were equal to those of grass with slightly less than 200 lb/a of N. Yields of harvested N in legume-orchardgrass swards were generally similar to those obtained from the legume-ryegrass mixtures.

Weed production was lower in legume-grass mixtures than from pure-seeded legume plots. Grass-component yields of mixtures were similar to those of grass stands with no applied N.

In 1981, alfalfa-ryegrass DM yields exceeded those of ryegrass receiving 400 lb/a of N by nearly a ton per acre. Trefoil-ryegrass and red clover-ryegrass yields were approximately equal to those of the grass with 200 and 165 lb/a of N, respectively. Legume-orchardgrass yields were similar to those of the legume-ryegrass mixtures, but orchardgrass yields with N were considerably higher than were those of N-fertilized ryegrass. At full seeding rates of alfalfa, legume herbage constituted 66 and 85% of total dry matter with orchardgrass and ryegrass, respectively. Comparable values for red clover were 42 and 68% and for trefoil, 46 and 75%.

Title: Effect of S Fertilizers on Alfalfa Yield and Mineral Element Composition

Leaders: G.A. Jung and J.A. Shaffer (U.S. Regional Pasture Research Laboratory)

The objective of this study was to determine the response of alfalfa to S source (fluidized bed material, K_2SO_4 , $MgSO_4$, $CaSO_4$, and elemental S) at rates of 70 and 140 kg S/ha.

Sulfur treatments were applied each spring of the 3-year study to six established stands (one each in Indiana, Union, Luzerne, and Huntingdon Counties, and two locations in McKean County). Each treatment was replicated four times at each site.

Samples were collected for yield and quality (protein and mineral content) determinations. Yield and quality data are currently being processed and analyzed.

Preliminary data indicate that there was no consistent trend for yields in 1979 and 1980, but there appeared to be some individual responses. For example, in 1980 at the Huntingdon County site, fluidized bed material appears to have increased yields by 23% at the 70 kg S/ha rate and by 18% at the 140 kg S/ha rate when compared with yields from check plots. A response of that magnitude was not obtained in 1979 in Huntingdon County or at any of the other five locations in either 1979 or 1980.

Title: Response of Warm-Season Grasses to Applied Fertilizer

Leader: G.A. Jung (U.S. Regional Pasture Research Laboratory)

In cooperation with NE-114 participants, we determined forage production of 19 cultivars of warm-season grasses with and without N fertilizer. The study is being conducted near State College, Pa. The grasses were sampled at head emergence and in October. First cut DM yields ranged from 4.40 mt ha⁻¹ for Kaw big bluestem to 10.15 mt ha⁻¹ for NJ 50 switchgrass with 75 kg N ha⁻¹, and from 2.98 mt ha⁻¹ for Plains bluestem to 8.37 mt ha⁻¹ for Ky 591 indiangrass with no N applied. The response to applied N ranged from 0.18 mt ha⁻¹ for Cheyenne indiangrass to 3.47 mt ha⁻¹ for Plains bluestem. Big bluestem and switchgrass responses to three rates of lime, nitrogen, and phosphorus on a poorly drained high aluminum soil, pH 4.6, were determined near Meadville, Pa. The N x P fertilizer interaction response was significant for both grasses. Application of lime increased switchgrass yields more than it did bluestem yields. Application of P without applied N or lime resulted in the lowest yields (lower than checks). First cutting DM yields of bluestem ranged from 3.04 mt ha⁻¹ to 8.51 mt ha⁻¹ and of switchgrass from 3.74 mt ha⁻¹ to 12.98 mt ha⁻¹.



SECTION VII
ENGINEERING RESEARCH



Title: Use of Dessicants in Forage Drying and Modeling of Forage Harvest Losses and Quality Changes During Silage Fermentation

Leader: R.E. Pitt (Cornell University)

The objective in modeling losses in forage harvesting systems is to calculate the long-term average yield and variance in yield, taking into account the probabilistic influence of weather on the delay in cutting due to rain, the time to dry forage to a given moisture content, leaching losses, and respiration losses. The model also calculates the harvesting energy requirements depending on the field machinery in use, the average distance of transport, and the type of storage. Results of the model show clearly the trade-off between reduced dry matter losses and increased energy requirements among various systems. These results have been used in the development of a criterion for evaluating the efficiency of forage harvesting systems in terms of their yield versus energy use. Future effort will be directed at predicting the nutritional quality of forage after harvesting.

Laboratory and field research has been conducted on the application of dessicants to increase the drying rate of cut forage in the field. Laboratory studies have shown that drying times for legumes can be reduced by as much as 50% using solutions of potassium carbonate, a methyl ester, and a surfactant. Field trials in which the dessicant is applied at the mower-conditioner at the time of cutting have thus far exhibited only about a 20% decrease in drying time. Thus, the current objectives are to improve the quality of application in the field, to assess the effect on field losses and forage quality, and to determine the field conditions that maximize the improvement on drying rate due to the dessicant. The system has potential as an inexpensive method of improving the flexibility in timeliness of forage harvesting and reducing the damage due to weather.

The third major emphasis is on studying the changing physical and biological conditions during fermentation of material stored in a silo. The basic purpose is to develop a mathematical model to predict the changes in forage quality during fermentation. Models have been derived to predict silage density, pressure, and temperature at any point in the silo. A comprehensive model is in development for simulating the actions of respiration, growth of lactic acid bacteria and clostridia, and changes in pH, buffering capacity, gross energy content, protein- and ammonia-nitrogen, and dry matter content. The model will use the earlier predictions for temperature and density and will be based on theoretical enzymatic and bacterial

growth models and published data on the micro-organisms and on silage fermentation. Further data will be collected in conjunction with a project on silage additives in the Department of Animal Science.

SECTION VIII

NUTRITIVE EVALUATION AND
UTILIZATION



Title: Additives for Ensiling, Formaldehyde for Hay Crop, Ammonia for Corn, and Other Additives for Sorghum

Leaders: D.R. Waldo and H.K. Goering (Beltsville Agricultural Research Center)

Thirty-two Holstein steers were fed direct-cut alfalfa silage that was ensiled either untreated or with 12% formaldehyde and 0.15% formic acid on a fresh basis. These two silages were fed either alone or with supplemental formaldehyde-treated casein. Daily gains on treated silage were double those on untreated silage when no casein was fed; supplemental casein removed about 40% of the difference. The differences in empty body weight gain from slaughter balance were not as large because digestive tract fill change was greater as animals gained more. Protein deposition in the total empty body on treated silage was double that on untreated silage when no casein was fed; supplemental casein removed about one-half of this difference. Energy deposition in the total empty body on treated silage was about one-third more than on untreated silage when no casein was fed; this increase was not changed by feeding casein. Energy deposited as protein in the empty body was only 25% of total energy on unsupplemented untreated silage but increased to between 36 and 39% with casein supplementation or feeding the treated silage alone.

Title: Nutritive Evaluation of Forage Following Minimum-tillage Renovation

Leaders: D.M. Coates, J.B. Holter, and D.W. Koch (University of New Hampshire)

A field consisting primarily of smooth brome grass and quackgrass on which alfalfa had thinned considerably was seeded by minimum tillage with alfalfa. Treatments also included an unseeded check fertilized with 48 kg of N. Application of paraquat and glyphosate were the two treatments prior to minimum-tillage seeding. No N was applied to the alfalfa-seeded plots, but all treatments received the same level of P and K. Dry matter yields the seeding year were 5.6, 2.7, and 2.7 mt/ha for unseeded, paraquat-treated, and glyphosate-treated plots, respectively. This illustrated the considerable effect of sod suppression associated with spring seeding. In late June, the year of seeding, alfalfa percentages were 22, 40, and 80% for the control, paraquat-, and glyphosate-treated plots, respectively. In the second year, seasonal yields were 4.5, 6.0, and 5.6 mt/ha and average alfalfa percentage was 26, 40, and 90%, respectively, for control, paraquat-, and glyphosate-treated plots. The first cutting was stored as hay crop silage and the second as hay. Dairy heifers weighing approximately 270 kg were used in feeding trials. There were

no differences among treatments in dry matter intake of forage from the first harvests the year after renovation. There was less digestible and metabolizable energy per unit of dry matter as the proportion of alfalfa increased. Although protein content of hay crop silage from renovated plots was 2 to 4% higher than that from unseeded plots and nitrogen intake was greater, nitrogen balance, the percentage of nitrogen retained in the body, was less. This indicates that the nitrogen was not as fully utilized in the high-legume hay crop silage. Forage from paraquat-treated plots was highest and forage from unseeded plots was lowest in total digestible nutrients and digestible dry matter.

Title: Metabolic Adaptations in Cattle on Spring Pasture

Leaders: J.E. Van Eys and R.L. Reid (West Virginia University)

Following a period of hay feeding, six rumen-fistulated steers were allocated to three pasture types: Kentucky 31 tall fescue, Kenhy fescue, and red clover-Kentucky 31 fescue. Rapid increases in ruminal concentrations of $\text{NH}_3\text{-N}$, K, P, Ca, VFA's, and in osmotic pressure (OP), occurred; increases were more gradual on red clover pastures during the first week of grazing, but animals on legume pastures maintained higher levels of Ca, Mg, VFA, and OP in subsequent grazing periods. Differences between pastures were only significant ($P < 0.05$) for Ca and Mg, but period effects were always large ($P < 0.0001$). The effect of sampling time within days was only important ($P < 0.05$) for ruminal Na, P, and osmotic pressure. Rumen osmolality ranged from 254 to 368 m osmoles and was most closely related to concentrations of VFA's and $\text{NH}_3\text{-N}$ ($R^2 = 0.66$). Osmolality of blood plasma followed rumen osmotic pressure but was generally hypotonic (282 to 306 m osmoles). Plasma concentrations of K and P increased immediately after animals went on pasture while Mg decreased; Mg levels returned most slowly to normal values. Grazing initiated a marked increase ($P < 0.05$) in liquid and solids turnover rates (CoEDTA and YbCl_3 , respectively), and rumen digesta volumes decreased ($P < 0.05$). As grazing continued, volumes increased ($P < 0.001$) and turnover rates returned to hay feeding values. Dry matter outflow from the rumen remained constant. Liquid and solids turnover rates were related positively to molar percent propionate ($r = 0.63$ and 0.48) and negatively to acetate ($r = -0.54$ and -0.44). Stepwise regressions of turnover rates on rumen fluid composition were: $k_1 = 11.13 - 0.33 \text{ P} + 0.37 \text{ propionate} - 2.26 \text{ isovalerate}$, $R^2 = 0.59$; and $k_s = 7.35 - 0.23 \text{ P}$, $R^2 = 0.25$, where the independent variables are in m moles/l. Rumen osmotic pressure was related ($P < 0.001$) to liquid volume but not to rates of turnover.

Title: Improving the Nutritive Value of Low-quality Cellulosic Feedstuffs by Chemical and/or Physical Means

Leader: J.B. Reeves, III (Beltsville Agricultural Research Center)

Residual Nutrition Lab

Most of the effort within the past year centered on use of nitrobenzene oxidation of feeds as a means of studying lignin composition. Extensive studies on the technique itself have resulted in the discovery of errors in the interpretation of results because of previously unreported by-products. Extensive studies using nitrobenzene oxidation and pyrolytic gas chromatography have been conducted on both chemically treated and nontreated feeds. These data are presently being analyzed for the purpose of evaluating utilization of lignin composition, as a measure of feed digestibility and alterability. ←

All data using pyrolysis-gas chromatography have also been entered into the computer for analysis. "

Method development work on use of permanganate oxidation of feeds to measure lignin condensation has almost been completed. Extensive testing has been completed to develop a useful and convenient procedure for using this assay.

Title: Warm-Season Grasses in Grazing Systems for Beef Cattle

Leaders: R.L. Reid, L.P. Stevens, L.C. Vona, and G.A. Jung (West Virginia University and U.S. Regional Pasture Research Laboratory)

Five warm-season grasses (switchgrass, indiangrass, big bluestem, Caucasian bluestem, Plains bluestem) were evaluated as components of grazing systems based either on cool-season forages (bluegrass-white clover, tall fescue) or on cool-season pastures plus warm-season grasses (WSG) used to bridge the summer gap. Replicated 0.9 ha pastures were established on a droughty upland soil on the Reymann Farm in the eastern panhandle of West Virginia. Measurements and management systems were: (1) ADG of yearling cattle on native pasture (Kentucky bluegrass-white clover) through the grazing season; (2) ADG on Kentucky 31 tall fescue through the grazing season; (3) ADG of cattle on native pasture in spring (May-June), followed by transfer to each of the WSG when they reached grazing height (mid-late June), return to native pastures in August-September, and utilization of regrowth of the WSG in September-October. Yearling heifers and fistulated steers were set-stocked at the rate of 4 units/0.9 ha (3 heifers and 1 steer). In four trial

periods, digestibility, intake, and rumen fluid composition were estimated. Data indicate that: (1) during the first 7 weeks of grazing either bluegrass-white clover or fescue pastures gains were low--0.32 kg/day on bluegrass, 0.20 kg/day on fescue; (2) ADG on WSG in the first 3 weeks were high, ranging from 0.82 kg/day on big bluestem to 1.14 kg/day on switchgrass and Caucasian bluestem; during the same period, gains on bluegrass were 0.74 kg/day and on fescue 0.78 kg/day; (3) WSG provided 53 days of grazing at a high stocking rate in the first growth cycle; mean ADG's in this period were: bluegrass-clover, 0.43 kg; tall fescue, 0.38 kg; big bluestem, 0.59 kg; Plains bluestem, 0.63 kg; switchgrass, 0.73 kg; indiangrass, 0.50 kg; Caucasian bluestem, 0.85 kg; (4) WSG gave a further 25 days of regrowth grazing in September-October; mean ADG's were: bluegrass-clover, 1.49 kg; tall fescue, 1.03 kg; big bluestem, 0.95 kg; Plains bluestem, 1.07 kg; switchgrass, 1.08 kg; indiangrass, 0.80 kg; Caucasian bluestem, 1.14 kg; (5) initial chemical analyses on the WSG indicated protein concentrations ranging from 7.0 to 10.0% in early first growth, decreasing to 4.5 to 7.0% in mid-July; concentrations of P, K, and S were lower than in cool-season species, and fiber fractions were higher. IVDMD values of clipped herbage ranged from 55 to 65% for WSG in June, decreasing to 45 to 55% in July; DMD coefficients were consistently lower than for bluegrass-clover and fescue herbage. The technique of emptying rumens and collecting rumen ingesta after a period of 30 min grazing for IVDMD determination gave lower values than expected and appears to be a questionable procedure. Results so far obtained indicate that the use of WSG for mid-summer grazing in conjunction with cool-season pastures in spring and fall enables higher stocking rates to be maintained during the grazing season and supports good ADG's in growing-fattening cattle.

Title: NE-108--Optimizing Intake and Digestibility of Forages by Ruminants: Calcium Nutrition

Leaders: J.L. Evans, James Wohlt, and E. Bakos (Rutgers University)

Twenty Holstein cows of three different age groups (8 at 25 months; 8 at 41 months; and 4 at 67 months) were randomly distributed within age groups into four diet Ca treatment groups. Diet phosphorus (P) and magnesium (Mg) were maintained at constant levels in all diets. Graded levels of diet Ca from ground limestone were 0.38, 0.55, 0.72, and 0.89%. These levels of Ca were estimated to represent 70, 100, 130, and 160% of the NRC recommended daily requirement.

Endogenous Ca loss obtained by the regression of fecal Ca on ingested Ca was $82.3 \text{ mg/BW}_{.75}^{\text{kg}}$ or 16.4 mg/kg body weight or 10.25 g/625 kg cow. No effect of age of cow or level of diet Ca on the endogenous Ca loss was found; however, diet acid load or buffer can change these values.

With an increase in ingested Ca from the diet, the grams of truly absorbed Ca were increased while the percent of truly absorbed Ca was decreased. True absorption of Ca ranged from 41 to 33%. The largest amount of truly absorbed Ca was 47 g/625 kg cow at 33% with the highest level of diet Ca. These data suggest that the 1978 NRC recommendations for diet Ca for the lactating bovine should be increased by 30 to 40%. In addition, an upward adjustment for the 1978 NRC recommendations for Mg and P is supported by the balance data on Mg and P in this report with elevated diet Ca.

In the data reported here, milk production was lowest for the first lactation cows and for the cows ingesting 0.38% diet Ca. Cows that demonstrated a true Ca absorption of 33% and 47 g/day produced the highest average of 33 kg milk/day. Milk production efficiency per unit of ingested diet dry matter increased from 1.74, 2.25, 2.29 to 2.55 with increments of diet Ca from 0.38, 0.55, 0.72 to 0.89%. The older cows were more responsive to diet Ca. In other words, the older cows have a higher DMI potential, and a part of this response in milk production reflects the influence of DMI on milk production via the influence of diet Ca on DMI.

Other data suggest that diet protein, source of phosphorus, and source of Ca can influence diet buffer potential. Bone can be considered a mineral reserve as well as a buffer reserve. Indicators of mineral reserve status of the body that we have reviewed are serum hydroxyproline (OHP) urinary adenosine monophosphate (cAMP).

An OHP increase in serum indicates bone loss, and a cAMP increase in urine indicates Ca reabsorption. For example, a higher level of diet protein, Ca carbonate not Ca lactate, and buffered phosphate not acidic phosphate, lowered serum OHP, elevated femur specific gravity, and elevated urinary cAMP in most cases. Higher protein elevated urinary loss of phosphorus and Ca. Equal levels of phosphate in buffered form reduced the urinary loss of phosphorus and Ca from high protein. Ca carbonate tended to elevate urinary phosphorus with higher protein and to give a variable response for urinary Ca.

Title: Nutritive Quality of Different Combinations of Grasses and Legumes

Leaders: R.L. Reid and W.C. Templeton, Jr. (West Virginia University and U.S. Regional Pasture Research Laboratory)

To examine possible interactions between grass and legume components present in different proportions in forage diets, two cuttings of pure stands of Saranac-AR alfalfa, Arlington red clover, Pennlate orchardgrass, and Reveille perennial

ryegrass were harvested at the Rock Springs Agricultural Research Center, Pa. For each cutting, each legume was mixed with each grass in five different combinations, viz. 100% legume; 75% legume/25% grass; 50% legume, 50% grass; 25% legume, 75% grass; 100% grass. Each treatment was weighed, chopped, and mixed thoroughly in a grinder-mixer. Treatments were fed to 6-month-old wether lambs (ca. 40 kg) in stainless steel metabolism crates; each treatment was fed to six lambs for 3-week periods, with fecal and urine collections during the final 7 days. Mean DMD's for the pure species in first and regrowth cuttings were: alfalfa, 64.1, 61.8%; red clover, 65.3, 66.7%; orchardgrass, 62.7, 57.1%; perennial ryegrass, 63.1, 65.1%. Corresponding intakes, in g/kg BW^{.75} were: alfalfa, 80.8, 64.6; red clover, 76.5, 88.6; orchardgrass, 63.7, 55.0; perennial ryegrass, 61.5, 64.2. In the first cutting, DMD's of mixtures tended to be lower than means of pure grass and legume components; the same was true for alfalfa/perennial ryegrass mixtures in the regrowth. Intake values for different mixtures of grass and legume in both cuttings were intermediate between those of pure grass and legume components. Mineral absorption and retention estimates will be calculated.

Title: Improvement in Protein Utilization of Forages by Formaldehyde and Heat Treatment

Leaders: H.K. Goering and D.R. Waldo (Beltsville Agricultural Research Center)

Further analyses and interpretation of the comparison of orchardgrass and alfalfa each harvested at two maturities have been made relative to protein utilization as measured from slaughter balance. Protein deposition in the empty body was essentially a linear function of autoclaved-rumen-fluid, insoluble nitrogen minus acid detergent insoluble nitrogen on the four forages. The maximum protein deposition was 172 g/day in these Holstein steers with final live weight of about 335 kg. On the contrary, the fraction of total energy deposited as protein declined from 67 to 34% as the dietary insoluble fraction of nitrogen increased. For further consideration of factors in the protein utilization, energy deposition in protein and energy deposition in fat were plotted as functions of total energy deposition. The four pairs of points from the four diets fall on two straight lines. Energy deposition as fat increased much faster than energy deposition as protein when total energy deposition increased. Differences in grams of protein deposition and fractional energy deposition are integrated by the consideration of total energy deposition. The major difference in these four forages is from energy available for deposition or the ad libitum intake of the forages.

Title: Optimizing Intake and Utilization of Forage and Protein by Ruminants

Leaders: M.I. Poos and S.J. Herbert (University of Massachusetts)

The objective of this trial was to evaluate various combinations of corn and soybeans planted in alternate rows and harvested as silage.

Silages were harvested after corn had reached the black layer formation stage. The soybeans at this time still had green pods, but vegetative portions of the plant had started to dry. Material was stored in 5 x 8 ft concrete silos. Treatments ensiled were 100% corn, 67% corn:33% soybeans, 50% corn:50% soybeans, and 100% soybeans. Nutrient analyses of the ensiled material gave the following information: (1) dry matter was 33.8, 36.6, 30.2, and 30.8% for the four respective treatments; (2) crude protein averaged 8.8, 9.7, 11.9, and 21.4% indicating that planting soybeans between rows of corn increased the protein content of harvested material as expected; (3) acid detergent fiber levels for the four treatments were 20.2, 23.8, 23.7, and 33.6%.

Digestibility studies were conducted using 24 mature, non-pregnant Dorset ewes averaging 47.3 kg. The experimental forages were fed for a 10-day preliminary period followed by a 5-day digestion trial. Dry matter intakes were 809, 830, 874, and 798 g for 100% C, 67% C:33% S, 50% C:50% S, and 100% S, respectively. Dry matter digestibility was 59.5, 64.3, 59.0, and 58.2%. Crude protein digestibility was 44.6, 58.2, 58.8, and 78.0%. ADF digestibility was 47.4, 53.3, 46.0, and 51.0%.

Intakes were greater on the mixed silages than on the 100% corn or 100% soybean silages. Crude protein digestibility increased with increasing protein content of the silage as was expected. Fiber digestibility was improved on the 67% C:33% S mixture but not the 50% C:50% S. The reason for this is not clear.

Due to low dry matter yield per acre, as well as poor intake and fiber digestion, it was concluded that 100% soybean silage is not a practical forage for Northeastern livestock producers. The 67% C:33% S and 50% C:50% S mixtures are being evaluated further.

Title: Protein and Mineral Metabolism of Sheep: Testing of Rations Containing Sources of Insoluble Protein to Promote Lamb Growth on Pasture

Leader: G.P. Lynch (Beltsville Agricultural Research Center)

Two groups of spring ewe lambs were fed 500 gm/head daily of a ration containing soybean or soybean plus fishmeal protein for 10 months. The combination of soybean plus fishmeal produced similar body weights but increased shoulder heights (+2.2 cm). Serum calcium was higher in the soybean and fishmeal group. Phosphorus, glucose, and albumin decreased during the grazing season but increased during winter feeding. Globulin, bilirubin, and urea nitrogen were highest during the grazing season. These results indicate that fishmeal may affect skeletal size via protein or mineral metabolism. A blood metabolite such as serum urea nitrogen may indicate the amount of protein consumed during various stages of the grazing season.

Title: Plant Availability of Micronutrients at Varying Soil pH Levels

Leaders: D.K. Markus and R.W. Duell (Rutgers University)

Research continued on effects of soil reaction on the availability of soil iron, manganese, copper, zinc, and boron for forage crops.

Field plots represented a broad pH range (3.5 to 7.5). DTPA, double acid, and 0.1N HCl extractants were used to estimate plant-available amounts of the micronutrient elements studied. Millet, sorghum, vetch, rye, barley, and soybeans were the test plants during the first 4 years of the study.

In phase I (1978-1979), the extractable amounts of native and residual soil micronutrients were determined. The correlation between soil levels of these micronutrients with plant tissue composition was investigated.

In phase II (since 1980), effects of native and applied micronutrients on production and micronutrient content of forage crops have been studied. Rye plants harvested May 19, 1981, showed considerable tolerance to soil reaction from the lowest (3.5) to the highest (7.0) pH levels. Whole-plant tissue analyses indicated that above pH 5, rye plants contained nearly the same amounts of the above micronutrients from treated and untreated soils. At lower soil pH levels, additions of micronutrients increased elements other than copper.

Title: Production Systems for Increasing Efficiency of Small Farms

Leaders: H.W. Harpster, W.L. Kjelgaard, W.C. Stringer, and
 W.C. Templeton, Jr. (The Pennsylvania State University
 and U.S. Regional Pasture Research Laboratory)

A marginal land site was developed at which four pasture-production and utilization systems are being tested. In the S1 and S2 systems, no mowing of weeds nor mechanical or herbicidal removal of brambles, bushes, and shrubs was done (approx. 30% brush cover) and seed was broadcast on the surface. S3 was cleared by hand of shrubs and bushes initially. Limestone and fertilizer were applied at one-half recommended amounts and seed was surface-seeded with no soil tillage. S4 was cleared of bushes and shrubs, and large weeds were mowed. Recommended amounts of lime and fertilizers were broadcast on the surface, and seed was planted with a minimum-tillage seeder. S1 pastures were grazed by sheep and goats and the remaining systems by sheep only. S1 and S2 treatments were continuously grazed while S3 and S4 treatments were divided into quadrants and rotationally grazed. One-fourth of the area in S3 and S4 contained only grasses fertilized with nitrogen. Two replications of each system were employed, and the put-and-take system of grazing was used. The area of land devoted to each replication-system combination was based on a sufficient area being used to accommodate at least four tester ewes and their lambs. Tester animals were of Dorset (1/2) x Suffolk (3/8) x Western (1/8) breeding and were bred to Rambouillet rams.

Preliminary results were summarized for the 1981 grazing season. Ewe and lamb grazing days per acre were 120, 177; 157, 246; 291, 437; and 635, 925 for S1, S2, S3, and S4, respectively. Total lamb gains (lbs/acre), and rate of gain (lbs/day) were 72, 0.41; 90, 0.37; 192, 0.44; and 378, 0.41 for the four respective systems. In addition to the sheep production data for the S1 pastures, a total of 176 goat grazing days per acre was obtained. Visual observations of sheep and goat grazing behavior were made and indicated a difference in the plant species preferred by each. Even when common grasses and legumes were available, goats demonstrated a preference for browse and forbs, including gray dogwood, Cornus sp.; thistles, Cirsium sp.; sumac, Rhus sp.; and goldenrod, Solidago sp. In many cases, goats were able to remove leaves from tall growing brush and brambles to heights exceeding 6 feet. In these areas, a notable increase in the growth of common grass and legume species was observed, undoubtedly due to improved sunlight penetration.

Title: Utilization of Digestible Energy in Cattle

Leaders: H.F. Tyrrell, P.W. Moe, and P.J. Reynolds (Beltsville Agricultural Research Center)

A procedure was devised for measuring concentrations of volatile fatty acids in blood, using vacuum sublimation and automated gas liquid solid chromatography. First harvest alfalfa was ensiled as direct-cut forage alone or with the addition of formic acid plus formaldehyde during the 1980 harvest season. These silages were fed either as the only source of nutrients or supplemented with formaldehyde-treated casein for yearling Holstein steers in a combined calorimetry and slaughter-balance experiment. Calorimetric measurements were made using eight steers (average weight of 309 kg) fed the four rations at the rate of 100 g DM/Wt^{0.75}/day in a replicated 4 x 4 latin square experiment. Metabolizable energy intake was not different among the four rations nor was tissue energy retention, although there was a trend towards lower energy retention when steers were fed formic-formaldehyde-treated silages ($P > 0.134$). Tissue nitrogen retention increased significantly when untreated silage was supplemented with casein or when steers were fed treated silage. No response to supplemental casein was observed in steers fed treated alfalfa silage. It is concluded that nitrogen from the treated alfalfa silage is adequate to support maximal tissue protein synthesis by Holstein steers fed a forage-based ration, whereas nitrogen from the untreated silage is not. In the absence of adequate dietary nitrogen quality, steers retain energy as body fat rather than as tissue protein.

Title: Evaluation of a Year-round Grazing System for Small Farms

Leaders: A.M. Decker, J.H. Vandersall, and L.R. Vough (University of Maryland)

Steers were grazed on summer pastures (April 13 to October 5) for a 175-day grazing season. All pastures were in the third year of grazing following no-tillage alternate row species seedings of birdsfoot trefoil-white clover-red clover, crownvetch-white clover-red clover, and white clover-red clover mixtures. Average daily gains tended to be lower with the red clover than with the other two mixtures, with the trefoil being higher for all steers. Live weight gains per hectare were also lower for the red clover mixtures. This is not surprising since both the stocking rate and daily gains were lower for this mixture.

Title: Physiology of Digestion in the Ruminant

Leader: L.W. Smith (Beltsville Agricultural Research Center)

Further interpretations were made of data from a series of five experiments on forage cell wall particle size degradation in a wether. Using quantitative dry sieve methodology and computation of size distribution data transformed to $\ln$ mean size (μ) and $\ln$ standard deviation (σ), it was demonstrated that forage cell particle degradation occurs solely in the rumen within the bounds of these experiments. Standard deviations of μ 's were different on samples from the rumen, duodenum, and feces, being larger for larger mean size particle distributions. On a relative basis ($\frac{\sigma}{\mu} \times 100$) the coefficient of variation was nearly constant, ranging from 11 to 12%. This means that particle size distributions from these five experiments with different μ C¹⁴ cell walls dosed and cell walls sampled at the rumen, duodenum, or the feces fit an array of parallel lines in the $\ln$ normal distribution system proposed for describing cell wall particles. Two models were tested to measure the rate of μ cell wall particle degradation in the rumen. They were a two-pool exponential model and an asymptotic model. The R^2 exceeded 0.999 for fitting μ in the rumen to time for both models. Residual sums of squares were small (<0.10) for both models. The asymptotic model computed by the Multivariate Secant method provided the best general fit of experimental data encompassing situations for which the mean size of particles degraded and also situations for which the mean size of particles were at or below the asymptotic size.

Title: Protein Level in Concentrate Supplement for Cows
Grazing High-Quality Pasture

Leaders: E.M. Kesler and W.C. Stringer (The Pennsylvania State University)

Two groups of 12 multiparous Holstein cows grazed rotationally on pastures in which existing grasses had been interseeded with red clover. Cows averaged 90 days in lactation and 37.3 kg milk daily at start of trial. They were fed concentrates calculated to contain 16 or 10% crude protein at the rate of 1 kg/3 kg 4% fat-corrected milk. Duration of trials was for two 8-week periods in a reversal design. Average milk production on the 16% protein concentrate was 30.7 kg; that on the 10% protein was 30.2 kg. Intake of concentrates averaged 9.3 kg on both treatments. Observed forage parameters are in process of analysis.

Title: Replacing Twenty Percent of Concentrate with Ground Hay in an Alfalfa-based Diet for Early-Lactation Cows

Leaders: Rebecca Baldwin, E.M. Kesler, and G.L. Hargrove
(The Pennsylvania State University)

Multiparous Holsteins were assigned to either of two groups of 10, based on previous production and lactation number, and groups were assigned to treatment at random. Cows were fed mixed alfalfa-grass hay; alfalfa haylage; and concentrate based on corn, oats, and soybean meal. Ground alfalfa hay replaced 20% of concentrate ingredients for one group. Cows were on trial for 109 days, beginning 3 days postpartum. Individuals were fed to extent of appetite with restriction that percentage of concentrate dry matter did not exceed 65 (52.0% if the 20% ground hay was considered as forage). Daily intakes of dry matter averaged 26.0 and 25.1 kg, and that of crude protein 4.4 and 4.1 kg/cow, by groups fed 0 and 20% ground hay, respectively. Dry matter digestibilities, determined at 60 and 110 days of lactation by the acid insoluble ash method, did not differ between treatment groups. Average daily yields of milk and fat-corrected milk were 36.9, 33.5 and 31.9, 31.6 kg, respectively, for the 0 and 20% groups. Fat percentages were 3.2 and 3.7, and those of protein 3.2, 3.2, respectively. Cows fed the ground forage tended to lose slightly more body weight and to be slower in regaining the loss. There were no health or reproductive problems related to treatment. The results suggest that high quality ground alfalfa can be used to replace a moderate amount of concentrate for high producing cows.

Title: Growth and Physiological Parameters of Ruminants Grazing Different Varieties of Tall Fescue

Leaders: James Bond, G.P. Lynch, and D.J. Bolt (Beltsville Agricultural Research Center)

The objective of this experiment was to determine the effects of grazing and feeding hay from tall fescue on the growth and reproductive performance of ewes and the growth of their lambs. Results suggest that fertility may be reduced in ewes grazing G1-307 fescue and that lowered fertility is more likely caused by embryonic mortality than by fertilization failure. Plasma prolactin was rapidly and dramatically reduced in ewes grazing G1-307. The reduction in plasma PRL involved impaired pituitary secretion rather than lowered pituitary concentration. Plasma PRL may be a valuable tool to quickly evaluate the toxicity of various varieties or extracts of tall fescues.

Title: Sodium Bicarbonate and Magnesium Oxide Addition to Finishing Rations for Yearling Beef Steers

Leaders: L.D. Muller and H.W. Harpster (The Pennsylvania State University)

Eight Angus steers fitted with rumen cannulas were fed rations of snapped ear corn, corn silage, and a corn-based supplement (75:25 concentrate:forage) containing: (1) 0% buffers, (2) 1.0% NaHCO_3 , (3) 0.5% MgO , and (4) 1.0% NaHCO_3 + 0.5% MgO . The steers were abruptly switched to these diets from an alfalfa-grass hay diet to evaluate the addition of buffers on nutrient utilization, rumen metabolism, and ration adaptation. Dry matter intakes were greater for the buffered diets. Dry matter and fiber digestibility was improved with added MgO . Thus, the addition of buffers tended to increase the amount of total nutrients digested and improve the adaptation to the rations. No major differences were observed in rumen fermentation except for a reduced rumen dilution rate with added MgO .

In a feed lot trial, replicate pens of six yearling steers received the same dietary treatments including the abrupt switch from a long hay to a high concentrate diet. Overall performance (feed intake and weight gain) did not differ between diets; however, MgO appeared to be of value in the feeding period as steers adapted more readily to the high energy rations.

Title: Optimizing Intake and Digestibility of Forages by Ruminants

Leaders: L.S. Bull, M.R. Stokes, C.K. Walker, and R.M. Cleale (University of Maine)

Mixed hay crop forage (orchardgrass, smooth brome grass, alfalfa, and clover) was harvested on June 5 or June 25 (first cutting, same field) and stored as silage. Rations were formulated using each forage to meet the requirements for 2-year-old Holsteins in early lactation. Half of the animals on each diet also received a live-yeast culture. With this forage, for each delay in harvest of one day, 1% more concentrate was required to balance the ration for a lactating cow. Forage protein declined 0.18%/day, while purchased protein increased at a similar rate to that for concentrate (1%/day). Yeast improved ADF digestion by 10%.

In a second study, cows fed hay crop-silage rations with 70, 50, 30, and 0% concentrate, corresponding to stage of lactation, were used to study the influence of ration on digestion, especially with regard to associative effects.

Within concentrate percentage, level-of-intake influence on digestion was determined. First-cutting forage averaged 8 percentage units higher DDM than second-cutting material from the same acreage. Decline in digestibility with increasing intake averaged 2 to 3 percentage units per multiple of maintenance and was greatest for 0% concentrate. In a summary of 40 7-day trials in cows fed a ration of 70% concentrate:30% hay crop silage, the equation describing DDM (Y, %) vs DMI ($\text{g/kg}^{.75}$) is: $Y = 0.0088x + 74.05$, indicating no decline with intake increase, from $x = 110$ to 220. Adjusted for equal intake (3xmt) and using a DDM of 65% for the forage (measured) and 87 for the concentrate (NRC), measured deviation from expected DDM (% units) was: -5.5 (30% conc); -7.5 (50% conc); -6.0 (70% conc). Observed DDM data were: 65 (0% conc); 67 (30% conc); 68.5 (50% conc); 74.5 (70% conc).

In this study, cows also received 0, 68, or 114 g/d NaHCO_3 in latin square designs within each ration. Buffer addition did not affect mean daily feed intake or milk production measured during week 4 of each 30-day latin square period. Buffer addition reduced milk fat percentage vs control. Greatest milk production and DM intake per unit of body weight or metabolic body weight was achieved with 68 g/d NaHCO_3 and lowest with 114 g/d. Compared to control, buffer did not affect rumen liquid turnover (mean = 16.0%/hour) but increased mean rumen pH and minimum pH and decreased time spent below pH 6. Buffer increased time spent eating with the 70% concentrate diet but reduced eating time with the 30% concentrate diet. In contrast to the weekly mean data, analysis of daily data when eating behavior was recorded (during week 3 of each period) indicated that buffer increased DM intake when added to the 70% and 50% concentrate diets and increased milk yield with the 70% concentrate diet.

Title: Predicting the Feeding Value of Hay from Infrared Spectroscopy and Chemical Lab Analyses

Leaders: H.W. Harpster, E. Keck, P.J. Wangsness, S.M. Abrams, and J.S. Shenk (The Pennsylvania State University and U.S. Regional Pasture Research Laboratory)

Thirty forages of various species, cuttings, and maturities were harvested as field-cured hay in each of 2 years from various locations within Pennsylvania. Each hay was chopped and fed ad libitum to four growing sheep to determine intake and digestibility. Prior to each experimental period, intake of a standard alfalfa hay was measured to be applied as a covariate to intake measurements during the experimental period. During both the standardization and experimental periods, hay was fed to provide 10% feed refusal. The coefficient of determination (R^2) increased, coefficient of

variation (CV) decreased, and the F statistic for forage effect increased in all measures of intake with inclusion of the covariate. Laboratory analyses of forages, feed refusals, and feces included dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and lignin. In addition, forages were classified botanically by visual appraisal, in vitro dry matter disappearance (IVDMD) was measured, and the infrared (IR) spectra of all forages were determined. Ranges of values were: NDF, 43 to 82%; lignin, 4 to 14%; CP, 6 to 26%; IVDMD, 47 to 73%; dry matter intake (DMI, 25 to 45 g/kg BW; digestible dry matter intake (DDMI), 12 to 30 g/kg BW; and in vivo digestible dry matter (DDM), 45 to 67%. Stepwise regression indicated that IVDMD was the most consistent laboratory analysis predictor of both digestibility and intake. DDMI was predicted from IVDMD with a standard error (SE) of 1.62 units and R^2 of 0.85. IR spectra were related to forage composition and animal response in two ways: (a) data from all forages (2 years, n=30) were regressed on IR spectra, and (b) calibration equations were developed from year-1 forages (n=30) and used to predict composition and animal response in year-2 forages (n=30). Data are presented in the following form: parameter, SE-method a (SE-method b), R^2 -method a (R^2 -method b). Hay composition values were: CP, 0.84 (0.91), 0.97 (0.97); NDF 1.58 (2.74), 0.97 (0.96); ADF 1.25 (1.79), 0.94 (0.89); lignin 0.87 (1.69), 0.85 (0.85); and IVDMD 1.57 (2.14), 0.92 (0.87). Similar data for animal response were DDM 1.6 (2.35), 0.89 (0.84); DMI 2.07 (3.03), 0.80 (0.75); and DDMI 1.26 (1.98), 0.91 (0.79).

Title: Energy Value of Feedstuffs for Dairy Cattle

Leaders: P.W. Moe and H.F. Tyrrell (Beltsville Agricultural Research Center)

Summarization of an experiment, the preliminary results of which were reported last year, has been completed. Three rations were compared which contained essentially the same potential net energy value for lactation (NE_L) but contained different levels or sources of protein. The NE_L value of an 11% crude protein ration was 81% of its estimated potential value. When ration crude protein was increased from 11 to 15% using a soluble protein supplement (linseed meal), NE_L value was improved to 91% of its estimated value. But when ration crude protein was increased from 11 to 15% using an insoluble protein supplement (corn gluten meal), NE_L value of the ration was 98% of its estimated value. Digestible (DE) and metabolizable (ME) energy values of the three rations measured at maintenance intake using dry cows were consistent with estimated energy values and gave no indication of the differences measured using lactating cows fed at approximately 3.5 times maintenance intake. Differences in NE_L value of the

three rations were attributable to differences in ME value with no difference attributable to efficiency of ME use for milk production. These results indicate that response to dietary protein is related to a more efficient movement of dietary energy through the digestive process with the result that the cow is better able to extract the potentially metabolizable energy when rations are consumed at high intake by lactating dairy cows. Another experiment is in progress to help determine the generality of these results.

Title: Intake of Concentrate and Free-choice Forage in Lactating Dairy Cows

Leader: J.B. Holter (University of New Hampshire)

The objectives were to relate diet intake and nutritive values to productivity in dairy cows and to examine the effects on intake of substituting concentrates for forages. Animal productivity in terms of daily milk yield during early lactation in 79 multiparous cows fed corn silage, hay crop free-choice, and concentrate was predicted ($R^2=0.77$) from body weight (W), daily dry matter intake (DMI), diet TDN, and days in milk (DIM), but not from diet crude protein (CP) or crude fiber (CF) according to the first equation below. Solids-corrected milk (SCM) was predicted ($R^2=0.75$) from W, DMI, CP, and DIM, but not TDN or CF as shown:

$$\begin{array}{ll}
 \text{Milk}_{\text{kg}} = -128.4 & \text{SCM}_{\text{kg}} = 21.23 \\
 -0.2525 (W_{\text{kg}}) & -0.1438 (W_{\text{kg}}) \\
 +0.0002043 (W_{\text{kg}})^2 & +0.0001108 (W_{\text{kg}})^2 \\
 +8.218 (\text{DMI}_{\text{kg}}) & +1.941 (\text{DMI}_{\text{kg}}) \\
 -0.1606 (\text{DMI}_{\text{kg}})^2 & +2.123 (\text{CP}_{\% \text{DM}}) \\
 +4.286 (\text{TDN}_{\% \text{DM}}) & -0.05548 (\text{CP}_{\% \text{DM}})^2 \\
 -0.03088 (\text{TDN}_{\% \text{DM}})^2 & -0.03546 (\text{DIM}) \\
 -0.06286 (\text{DIM}) &
 \end{array}$$

Intake of dry matter was the most significant factor influencing these measures of productivity in dairy cows.

During the first two 28-day periods (56 days) postpartum under ad libitum feeding, each kilogram increase in concentrate DMI reduced forage DMI 0.75 kg in first-calf Holstein heifers and 0.64 kg in older cows according to the following equations:

Lactation 1, N = 60, $R^2 = 0.65$

kg Forage DMI = 12.4 - 0.75 (kg concentrate DMI)

Lactations >1, N = 150, $R^2 = 0.96$

kg Forage DMI = 15.1 - 0.64 (kg concentrate DMI)

Thus, ration DMI was increased only 0.25 and 0.36 kg/l kg increase in concentrate DMI, respectively, in early lactation. This means that a policy of increasing the level of concentrate feeding to enhance energy intake in early lactation would be of less value in first-calf heifers than in older cows and of little value in either age class when (with high-quality forage) the spread in energy content between forage and concentrate is narrow.

All consecutive 28-day periods (Period No.) postpartum for 105 complete lactations in Holstein cows of blended herd age were pooled to predict ($R^2=0.73$) daily forage DMI. Forage (0.63 corn silage, 0.37 grass silage) was fed ad libitum and concentrate was limited to meet energy requirements. The data base included observations used in the previous two equations.

kg Forage DMI = -1.77

-0.545 (kg concentrate DMI)

+0.0129 (W_{kg})

+0.230 (kg SCM)

+0.908 (Period No.)

Over complete lactations, each additional kilogram of concentrate DM fed reduced forage DMI 0.54 kg and increased total ration DMI 0.46 kg.

Title: Optimizing Intake and Digestibility of Forages by Ruminants

Leader: J.G. Welch (University of Vermont)

In rate of passage studies with plastic of different specific gravities, it was found that as particle size declined specific gravity had less effect on rate of passage through cattle. Goats and sheep of similar body size had similar rumination and eating times per unit at CWC. In mature goats, rumination time/g CWC declined with increase in body size. Young goats showed a large increase in rumination efficiency as they matured: 4.7 min rumination/g CWC at 2 months to 1.3 min rumination/g CWC at 9 months g. Ten sheep were trained and conditioned to walk 6.6 Km/day on a self-propelled treadmill. Sheep were subjected to 1- to 3-day periods of exertion, compared to the same length of rest, in four reversal

experiments. Dry matter intake declined during the exercise days and increased during the rest days ($P<0.05$). Rumination/g CWC increased during the exercise periods. Eating efficiency was unchanged. In breed comparisons, Scotch Highland heifers chewed more/g CWC ($P<0.05$) and had lower fecal DM on the coarse (2,400 micron and 1,200 micron) sieve sizes ($P<0.05$) than did similar dairy cattle. Scotch Highland heifers were compared in warm (+5.6 C) and cold (avg -9.1 C) environments. More rapid eating (196 min vs 261 min/day) for similar DM consumption was observed ($P<0.05$). The cold environment produced more rumination time/g CWC (-0.24 vs 0.201 ($P<0.05$)). There was no difference in fecal particle size produced in the two environments. Beef cattle subjected to extreme cold (-41 C and -42 C) produced coarser fecal particles than they did under warmer (-2 C) conditions.

Title: Infrared for Evaluating Forage Quality and Nutritive Value

Leaders: J.S. Shenk, M.R. Hoover, M.O. Westerhaus, W.C. Templeton, Jr., G.W. Fissel, and W.G. Lynch
(The Pennsylvania State University and U.S. Regional Pasture Research Laboratory)

A study was conducted to determine effects of forage species, drying methods, and harvests on accuracy of NIR predictions. Analysis of the data indicated that when calibration and prediction samples were similar, prediction accuracy improved. If all variables (species, drying method, and harvest) were represented in the calibration, relatively low prediction errors were obtained across all variables. These errors were ± 0.66 for protein, ± 1.97 for neutral detergent fiber, ± 1.02 for acid detergent fiber, ± 0.59 for acid detergent lignin, and ± 1.80 for in vitro dry matter disappearance.

The NIR van hardware and software configuration has been completed. The system includes a PDP-11/03 DEC computer with dual RX02 floppy disk, hard copy printer and video CRT, a Neotec 51-A scanning filter instrument, the network software, a dairy ration formulation program developed by Dr. Richard Adams (Professor, Dairy Extension, The Pennsylvania State University), and a beef ration formulation program developed by a graduate student (Arturo Martinez, Agronomy Department, The Pennsylvania State University). The van contains a microwave oven to dry high-moisture samples, a grinder/vacuum combination to process the sample, and a digital balance to measure moisture removed in sample processing. The van equipment can be operated from a shore power 110 volt, or by a 60 amp alternator/inverter electrical system from the van engine.

A new release of software was outlined and progress toward its development was achieved. It is hoped that this new release will be capable of reducing prediction errors by as much as 20% over current software. Additional time will be needed to complete this new version and adequately test it for release in 1982. The regression program has a visual output on a graphics terminal for use by those with graphic equipment. A new program has been written to control and collect data from the lower cost Neotec 51-A scanning filter instrument. This will allow the 51-A to use all the software for calibration and prediction.

Title: Establishment of National Forage Reference Library

Leaders: S.M. Abrams, J.S. Shenk, and W.C. Templeton, Jr.
(U.S. Dairy Forage Research Center (Cluster),
The Pennsylvania State University, and U.S. Regional
Pasture Research Laboratory)

The primary objective of this project is to collect, catalog, and maintain samples of forages fed to livestock in the United States, for the purpose of developing calibration equations relating near-infrared reflectance spectra to forage moisture, protein, and fiber content. In conjunction with members of the recently created National Infrared Project, hay samples will be solicited from all 50 states plus Puerto Rico, Guam, and the Virgin Islands, in proportion to their annual production, with a minimum of 25 samples requested from each state. Samples will be processed and stored at University Park, Pa. Moisture and infrared reflectance will be determined at University Park, protein at St. Paul, Minn., and fiber at Athens, Ga.

A major concern in the planning of the library was that moisture content be held constant, since the need for repeated analyses for moisture would deplete the resources of the library. In 1981, three types of sample containers were tested for their capacity to retard water flux: retort pouches (4.18 Mil), polyethylene sample bags with wire band closures (3.00 Mil), and polyethylene bottles with screw tops (80.00 Mil). Containers were filled with either 65 g calcium carbonate, a dessicant, or 25 ml water. Retort pouches were sealed for 10 sec on a hot sealing bar, sample bags were folded seven times and the tabs secured, and bottles were closed hand-tight with screw caps. Containers with water were placed in a 60 C forced-draft oven, and those with dessicant were suspended over water in a covered water bath at ambient temperature (25 C). Containers were weighed every 3 days over a 12-day period to determine the water transfer rate.

Water transfer rates were 16.98, 0.63, and 0.03 mg/day when filled with dessicant and -454.92, -14.32, and 0.10 mg/day when filled with water for polyethylene bags, polyethylene bottles, and retort pouches, respectively. The rate for the retort pouches filled with dessicant was nonsignificant ($P>0.05$), and the small, but positive, rate when filled with water is unexplained. It was concluded that the retort pouch is an excellent method for storage of moisture-containing materials when maintenance of moisture content is critical, and it will be the container of choice for this project.

Title: Dietary Buffer Effects on Forage and Nutrient Utilization by Lactating Dairy Cows

Leaders: L.D. Muller, J.A. Rogers, and T.J. Snyder
(The Pennsylvania State University)

Four rumen fistulated Holstein cows were used in a 4 x 4 latin square design with a 2 x 2 factorial arrangement of treatments to study the influence of added NaHCO_3 on milk yield and digestion with two corn silage:grain ratios.³ Total mixed diets were either 50:50 or 75:25 corn silage:grain with or without 1.2% NaHCO_3 in the total ration DM. Added NaHCO_3 significantly increased milk yield, milk fat percent, rumen pH at 4 hours post-feeding, rumen acetate:propionate, and ADF digestibility. Across diets, the ruminal rate of passage of liquid was faster than grain DM, which was faster than fiber DM. Higher corn silage diets increased rate of passage of liquid and solid particles. Added NaHCO_3 had little influence on rumen volume or rate of passage.

Title: Evaluation and Use of Meadow Voles as a Bioassay of Forage Quality and Model for Ruminant Animals

Leaders: T.V. Hershberger, R.L. Cowan, H. Rothenbacher, J.S. Shenk, W.A. Kendall, and W.C. Templeton, Jr.
(The Pennsylvania State University and U.S. Regional Pasture Research Laboratory)

Thirty forages representing various species (alfalfa, orchardgrass, bromegrass, and timothy), growth stages (early, medium, and late), and locations within Pennsylvania (Bradford, Hershey, and Rock Springs) were fed to both sheep and weanling meadow voles. Vole weight gain was significantly correlated with sheep dry matter intake ($r = 0.75$), sheep dry matter digestibility ($r = 0.68$), and sheep digestible dry matter intake ($r = 0.73$). Vole response was related primarily to the cell contents of the forage ($r = 0.84$).

The feasibility of using meadow voles as a bioassay for toxic constituents in tall fescue was investigated. Several samples of tall fescue seed that contained various levels of alkaloids and a fungus that are suspected to cause toxicosis in cattle were fed at 20 and 30 C. Vole intake, but not body weight gain, was inhibited by the high temperature. There were no differences in diet intake or body weight gain among the fescue samples. It was concluded that voles and cattle respond differently to toxic conditions in tall fescue.

A study with orchardgrass and dandelion to identify and evaluate constituents of forages that affect intake of single meals of meadow voles was continued. Crude extracts of orchardgrass with methylene chloride that inhibited intake were partitioned into fractions which were not inhibitory. Crude extracts of dandelion with acetone and with methanol enhanced intake, and these extracts are being further purified.

Title: Breeding Forage Grasses and Evaluation with Infrared Reflectance

Leader: J.S. Shenk (The Pennsylvania State University)

Progress in breeding for improved yield and quality in orchardgrass (*Dactylis glomerata* L.) is dependent upon genetic parameters and the number of outstanding entries that can be identified in a breeding program. This study was conducted with 101 late- and 130 medium-maturity clones selected to be vigorous and disease free from over 10,000 foreign and domestic clones. Progeny were planted in several triple lattice designs and harvested three times each year. Samples of each plot were dried and ground for prediction of crude protein, in vitro dry matter disappearance, and neutral detergent fiber by near infrared reflectance. Two selection indices, dairy herd selection index and relative feed value, were used to evaluate the progeny.

No consistent pattern of significant year x entry interaction was found for yield and quality traits over trials. Heritability estimates were low to medium (0.08-0.64), with heritability of quality traits (0.20-0.64) higher than for yield (0.08-0.61). Although a few significant negative genetic correlations were found, entries having both high yield and quality were identified. The range in a given trait was small, but late progeny generally had the greatest range. Approximately 3% of the progeny had both superior yield and quality traits. Identification of these superior entries was made easier by using a selection index.

Title: Grazing of Warm- and Cool-Season Grass Pastures on Droughty Soils

Leaders: R.L. Reid, G.A. Jung, L.P. Stevens, and W.L. Stout
 (West Virginia University and U.S. Regional Pasture
 Research Laboratory)

Beef cattle grazing trials were initiated at Wardensville, W.Va., with warm-season and cool-season grasses on droughty hill-land soils. Stocking rate used was 5 head ha⁻¹. DM yield determinations were made on 11 sampling dates. DM yields on June 22 ranged from 2.39 mt ha⁻¹ for Ky bluegrass-orchardgrass-white clover to 7.17 mt ha⁻¹ for switchgrass. Herbage availability began to limit animal performance in early August but least of all for Caucasian bluestem. Average daily gain from June 19 to July 28 ranged from 0.49 kg (1.08 lbs) on Ky 31 tall fescue to 0.94 kg (2.07 lbs) on switchgrass. Grazing from September 29 to October 23 gave ADG of from 0.80 kg (1.76 lbs) on indiangrass to 1.49 kg (3.28 lbs) on permanent pasture. ADG on Caucasian bluestem was 1.14 kg (2.51 lbs). Rainfall and available soil moisture were monitored during the growing season, but sampling soil for moisture determinations was limited by droughty conditions. Soil moisture levels were lowest in late July; at that time the Weikert-Berks soil complex contained approximately 2.5 cm and the Edom soil 3.7 cm of soil moisture in the surface 30 cm of soil.

SECTION IX
SILAGE AND HAY RESEARCH

Title: Effects of Extended Instantaneous Heating of Mixed Grass on Nutrient Compositions of the Forage, Silage, and Some Silage Fermentation Products

Leader: Heinrich Fenner (University of Massachusetts)

In two forage preservation experiments, the first and second growth of a mixed stand of orchardgrass and timothy were ensiled in four upright round concrete silos of 1.52 m x 2.44 m dimensions each with a storage capacity of about 2,700 kg (corn silage 25 to 27% dry). After harvest by field chopper, the grass was placed 0.7 to 1.0 m high on a shaded hardtop floor. Temperature in the forage rose up to 40 to 45 C. Each batch of forage for one silo was thoroughly blended in a mixer wagon. Silos were filled at 2, 8, 26, and 32 hr after harvest. Forage was sealed with plastic capped with sawdust and finally sealed airtight with plastic.

Using composition of forage for the first silo filling as a basis for comparison, the extended exposure to aerobic conditions raised in the forage the contents of dry matter, crude fiber, ash, and NPN, while the concentrations of true protein, carotene, NFE, and organic matter declined. The content of ether extracts remained unchanged. Fermenting the forage to silage lowered the concentrations of dry matter, true protein, NFE, and ash, while that of crude fiber, ether extracts, carotene, and NPN rose. Extended exposure of the forage to aerobic conditions before ensiling raised in the silage the pH value, the contents of total volatile fatty acids, the total acids (VFA and lactic acid combined), the contents of acetic and n-butyric acids, while it lowered the lactic acid content of the silage. The ammonia content fluctuated and did not show any preferential trend.

First growth forage produced silage with higher contents of total VFA's, total acids, and acetic acid, while the second growth forage produced lower pH values and higher contents of lactic acid.

Title: Hay Moisture Meter Evaluation

Leader: M.A. Sprague (Rutgers University)

Redesigned sensor probes of a direct-reading moisture meter for use in a windrow were evaluated on several hays during 1981. The electrodes having sharp points provided more consistent readings on most hays than those with pins having flattened tips. Acceptable accuracy was obtained on hays of up to 28 to 30% moisture content.

Title: Effects of Silage pH on the Voluntary Intake of Corn Silage

Leaders: R.D. Shaver, R.A. Erdman, and J.H. Vandersall
(University of Maryland)

Two studies were conducted to evaluate the effects of forage pH on corn silage intake. Fresh whole corn plant was harvested and either ensiled or frozen for later use in feeding Trial 1. Four growing (150 kg) Holstein steers were used in a 4 x 4 latin square design with 15-day experimental periods in Trial 1. Treatments consisted of: (1) fresh whole corn plant, (2) fresh whole corn plant acidified with hydrochloric acid to the pH of corn silage, (3) corn silage, and (4) corn silage neutralized with sodium bicarbonate (NaHCO_3) to the pH of fresh whole corn plant. All animals received 0.41 kg/day of a protein-mineral supplement. Silage pH, dry matter intakes, and organic matter intakes (kg/day) for the respective treatments were: (1) 5.20, 4.07, 3.91; (2) 3.66, 3.78, 3.62; (3) 3.86, 3.91, 3.74; and (4) 5.94, 4.58, 4.23. In Trial 2, 16 Holstein heifers (292 kg) were fed a control corn silage during a 2-week preliminary period. This was followed by an 8-week experimental period where animals were fed corn silage neutralized with 0, 2, 4, or 6% NaHCO_3 (DM basis). All animals received 0.61 kg/day of a protein-mineral supplement during the preliminary and experimental periods. Silage pH and least squares means for dry matter and organic matter intakes (kg/day), respectively, were: control, 3.72, 6.67, 6.40; 2.0% NaHCO_3 , 4.46, 7.76, 7.39; 4.0% NaHCO_3 , 5.62, 8.10, 7.60; and 6.0% NaHCO_3 , 8.05, 6.15, 5.67. We conclude that pH is a factor which affects the voluntary intake of corn silage and that pH 5 to 6 is optimum, while silage pH above and below may result in reduced intake.

Title: Effect of Silage pH on Intake of Alfalfa Haylage in Growing Heifers

Leaders: A.M. O'Connor, R.A. Erdman, and J.H. Vandersall
(University of Maryland)

Silage pH at the time of feeding may be a factor which affects voluntary intake of ensiled forages. This effect had not been tested in alfalfa haylage. Sixteen growing Holstein heifers (300 kg) were used in a 10-week experiment to test the effect of silage pH prior to feeding on intake. Animals were fed a control alfalfa haylage (42% DM, pH = 4.56) during a 2-week preliminary period, followed by an 8-week experimental period. Treatments included: (1) control alfalfa haylage, (2) control + 1.5% added NaHCO_3 (DM basis) prior to feeding, (3) control + 3.0% NaHCO_3 , and (4) control + 4.5% NaHCO_3 . Addition of NaHCO_3 raised pH to 4.98, 5.56, and 5.85 in the

respective treatment group. Mean DM intakes adjusted for preliminary intake for the control and respective groups were: 7.22, 7.98, 7.71, and 7.53 kg/day. Average daily gains for the control and respective treatment groups were: 1.80, 1.97, 2.19, and 2.12 kg/day. Highest level of DM intake occurred where 1.5% NaHCO_3 was added, while greatest improvement in gain was seen where 3.0% NaHCO_3 was added. It was concluded that addition of NaHCO_3 to raise the pH to 5.5 may have been optimal for increasing intake of ensiled forages.

Title: Silage Additives: Siloguard in Corn Silage for Dairy Heifers

Leader: J.B. Holter (University of New Hampshire)

High quality corn silage (30% DM) with 0.5% urea was ensiled with or without 0.075% additive in a 660-ton horizontal silo and fed as the sole diet to dairy heifers to evaluate effects on fermentation pattern, silo temperature, ad libitum intake, nutrient digestibility, and nutritive value. Temperature was 2°C lower, but dry matter storage efficiency (93%), measured by the buried-bag technique (measures fermentation loss), was not improved in treated silage. Fermentation pattern in terms of pH, $\text{NH}_3\text{-N}$, proximate nutrients, and organic acid levels indicated high-quality silages with no effect of additive. Ad libitum intake in 363-kg heifers was 5% more ($P < 0.05$) for treated silage. Total digestible nutrients in silage dry matter was significantly higher (70.0 vs 67.7%) for treated silage, primarily due to improved digestibility of crude fiber (60.3 vs 55.0%). Partition of ingested energy and nitrogen was not affected by treatments, but the body fat balance was 85 g/day more ($P < 0.05$) in heifers consuming the treated silage.

Title: Preservation and Nutritive Value of Corn-Plant Silages with and without Ammonia and Mineral Treatment for Growing and Finishing Steers

Leaders: H.W. Harpster, D.D. Loy, E.H. Cash, W.L. Kjelgaard, and P.M. Anderson (The Pennsylvania State University)

A 2 x 2 factorial experiment was designed to evaluate corn silage type (whole plant (WP), 50% grain, 50% forage; snapped ear corn (SEC), 75% grain, 25% forage) and method of nitrogen and mineral supplementation (anhydrous ammonia and mineral mix preensiling at the forage blower (T); urea and mineral mix post-ensiling at feeding time (UT)) for small to average frame Angus steers (247 kg). Pre- and post-ensiling values for (1) WP-UT, (2) WP-T, (3) SEC-UT, and (4) SEC-T silages were,

respectively: dry matter (DM, %) 28, 29; 31.5, 33.1; 73.6, 71.5; 70.8, 72.9; crude protein (% of DM) 7.3, 8.1; 7.1, 12.7; 9.1, 9.6; 9.5, 11.0. Respective mean pH values (weekly samples, n=26) for silages 1 to 4 were 3.62, 4.16, 4.18, and 6.23. Two pens of eight steers were assigned to each treatment combination, and all cattle received monensin at feeding (0.033 mg/g dry matter). WP and SEC steers were slaughtered after 205 and 189 days on feed. There were no significant ($P<0.05$) silage type (ST) x supplementation method (SM) interactions for any criteria. Daily DMI (kg), average daily gain (kg), and feed/gain values for cattle fed rations 1 to 4 were: 7.13, 7.81, 7.49, 8.02 (ST $P<0.10$, SM $P<0.01$); 1.03, 1.11, 1.16, 1.18 (ST $P<0.01$; SM $P<0.10$); 6.90, 7.05, 6.46, 6.81 (ST $P<0.10$). SM did not affect composition of gain as did ST. Adjusted to equal hot carcass weight (277 kg), carcass protein (%), and carcass fat (%), values for cattle fed rations 1 to 4 were, respectively: 14.70, 14.61, 13.65, 14.02 (ST $P<0.01$); 33.03, 33.31, 37.40, 35.85 (ST $P<0.01$). Other carcass parameters did not differ ($P<0.05$). Thus, ammonia/mineral treatment of the silages was a desirable alternative to urea/mineral supplementation at feeding, although benefits are diminished for SEC due to inhibitory effects on fermentation.



SECTION X

ENVIRONMENTAL RESEARCH



[There were no contributions for Section X for 1981.]

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RECIPIENTS OF
GRADUATE DEGREES

—M.S. DEGREES—

<u>Name - Institution - Advisor</u>	<u>Thesis Title</u>
REBECCA S. BALDWIN The Pennsylvania State University (E.M. Kesler)	Effect of replacing twenty percent of concentrate with ground hay in an alfalfa-based diet fed to cows in early lactation
NEAL S. BOGGESS West Virginia University (B.S. Baker)	Evaluation of purpletop, <u>Tridens flavus</u> (L.) Hitchc., for forage production in West Virginia
DAVID M. BURNER West Virginia University (J.A. Balasko)	Genetic and environmental variability in tall fescue
RALPH M. CLEALE, IV University of Maine (L.S. Bull)	The effects of live yeast culture and forage maturity on performance by lactating dairy cows
ALICE P. HOOPER University of Vermont (J.G. Welch)	A study of eating and rumination efficiency in sheep, kid goats, and mature goats
STEPHEN E. LEVENSON University of Massachusetts (Heinrich Fenner)	The effect of extended aerobic exposure of chopped grass on nutrient composition and fermentation pattern of silage
PRISCILLA S. MAC LEAN The Pennsylvania State University (R.A. Byers)	The effects of glandular and simple hairs (<u>Medicago</u> species) on ovipositional preference of the alfalfa blotch leafminer, <u>Agromyza frontella</u> (Rondani) (Diptera:Agromyzidae)
DANIEL J. MC PHERSON University of New Hampshire (G.M. Dunn)	Insect and mollusc pests in legumes established by minimum tillage
TSUTOMO OHNO Cornell University (D.L. Grunes)	Influence of aluminum on the chemical composition of winter wheat

<u>Name - Institution - Advisor</u>	<u>Thesis Title</u>
SARAH B. PIERCE The Pennsylvania State University (L.D. Muller)	Influence of sodium bicarbonate and magnesium oxide on digestion and metabolism in yearling beef steers
CELIA SMITH University of New Hampshire (D.W. Koch)	Crop planning for dairy farms-- a computer-generated linear programming model
LYNN E. SOLLENBERGER The Pennsylvania State University (W.C. Templeton, Jr.)	Some effects of legume species and seeding rates on the productivity and composition of legume-grass mixtures
JOHN H. STANGARONE University of Maryland (A.M. Decker)	Determination of potential for increasing nitrogen fixation by alfalfa cultivars
LINDA C. VONA West Virginia University (R.L. Reid)	Nutritive value of warm-season grass hays

--Ph.D. DEGREES--

C.K. DES BORDES University of Vermont (J.G. Welch)	Influence of specific gravity on rumination and passage of indigestible particles through the GI tract of Jersey cattle
PETER M. DOWLING Cornell University (D.L. Linscott)	Factors limiting the establish- ment of direct-drilled alfalfa (<u>Medicago sativa</u> L.)
GEORGE W. MUELLER-WARRANT University of New Hampshire (D.W. Koch)	No-tillage renovation of alfalfa stands
DONNA L. STADTMORE West Virginia University (R.L. Reid)	Selenium nutrition of ruminants on forage diets
JEAN C. STUTZ The Pennsylvania State University (K.T. Leath)	Various aspects affecting virulence of <u>Fusarium roseum</u> ' <u>Acuminatum</u> ' and <u>F. roseum</u> ' <u>Avenaceum</u> ' in red clover

Name - Institution - AdvisorThesis Title

R.W. TAYLOR
University of Connecticut
(D.W. Allinson)

Evaluation of indigenous grasses
and minimum tillage of legumes
for grassland pasture renovation

MARK L. WAHLBERG
The Pennsylvania State
University
(H.W. Harpster)

An energetic and economic
evaluation of feeding systems
utilizing the corn plant for
beef production



